SCIENCE

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ADDRESS OF THE PRESIDENT BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

I.

FOR the third time in its history the British Association meets in your City of Bristol. The first meeting was held under the presidency of the Marquis of Lansdowne in 1836, the second under the presidency of Sir John Hawkshaw in 1875. Formerly the President unrolled to the meeting a panorama of the year's progress in physical and biological sciences. To-day the President usually restricts himself to specialities connected with his own work or deals with questions which for the time are uppermost. To be President of the British Association is undoubtedly a great honor. It is also a great opportunity and a great responsibility; for I know that, on the wings of the press, my words, be they worthy or not, will be carried to all points of the compass. I propose first to deal with the important question of the supply of bread to the inhabitants of these islands, then to touch on subjects to which my life work has been more or less devoted. I shall not attempt any general survey of the sciences; these, so far as the progress in them demands attention, will be more fitly brought before you in the different sections, either in the addresses of the presidents or in communications from members.

Before proceeding with my address I wish to refer to the severe loss the British Association has sustained in the death of Lord Playfair. With Sir John Lubbock and Lord Rayleigh, Lord Playfair was one of the permanent trustees of our Association, and for many years he was present at our meetings. It would be difficult to overrate his loss to British science. Lord Playfair's well-matured and accurate judgment, his scientific knowledge, and his happy gift of clothing weighty thoughts in persuasive language, made his presence acceptable, whether in the council chamber, in departmental enquiries, or at light social gatherings, where, by the singular laws of modern society, momentous announcements are sometimes first given to the world. Lord Playfair (then Sir Lyon Playfair) was President of the British Association at Aberdeen in 1885; his address on that occasion will long be remembered as a model of profound learning and luminous exposition.

And now I owe a sort of apology to this brilliant audience. I must ask you to bear with me for ten minutes, for I am afraid what I now have to say will prove somewhat dull. I ought to propitiate you, for, to tell the truth, I am bound to bore you with figures. Statistics are rarely attractive to a listening audience; but they are necessary evils, and those of this evening are unusually doleful. Nevertheless, when we have proceeded a little way on our journey, I hope you will see that the river of figures is not hopelessly dreary. The stream leads into an almost unexplored region, and to the right and left we see channels opening out, all worthy of exploration and promising a rich reward to the statistic explorer who will trace them to their source—a harvest, as Huxley expresses it, 'immediately convertible into those things which the most sordidly practical of men will admit to have value, namely, money and life.' My chief subject is of interest to the whole world—to every race, to every human being. It is of urgent importance to-day, and it a life-and-death question for generations to come. I mean the question of food supply. Many of my statements you may think are of the alarmist order; certainly they are depressing, but they are founded on stubborn facts. They show that England and all civilized nations stand in deadly peril of not having enough to eat. As mouths multiply, food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent on difficult and capricious natural phenomena. I am constrained to show that our wheat-producing soil is totally unequal to the strain put upon it. After wearying you with a survey of the universal dearth to be expected, I hope to point a way out of the colossal dilemma. It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned into plenty.

The food supply of the kingdom is of peculiar interest to this meeting, considering that the grain trade has always been, and still is, an important feature in the imports of Bristol. The imports of grain to this city amount to about 25,000,000 bushels per annum, 8,000,000 of which consist of wheat.

What are our home requirements in the way of wheat? The consumption of wheat per head of the pupulation (unit consumption) is over six bushels per annum; and taking the population at 40,000,000, we require no less than 240,000,000 bushels of wheat, increasing annually by 2,000,000 bushels, to supply the increase of population. Of the total amount of wheat consumed in the United Kingdom we grow 25 and import 75 per cent.

So important is the question of wheat supply that it has attracted the attention of Parliament, and the question of national granaries has been mooted. It is certain

that in case of war with any of the Great Powers wheat would be contraband, as if it were cannon or powder, liable to capture even under a neutral flag. We must, therefore, accept the situation and treat wheat as munitions of war, and grow, accumulate or store it as such. It has been shown that at the best our stock of wheat and flour amounts only to 64,000,000 bushels—fourteen weeks' supply—while last April our stock was equal to only 10,000,000 bushels, the smallest ever recorded by 'Beerbohm' for the period of the season. Similarly, the stocks held in Europe, the United States and Canada, called 'the world's visible supply,' amounted to only 54,000,000 bushels, or 10,000,000 less than last year's sum-total, and nearly 82,000,000 less than that of 1893 or 1894 at the corresponding period. To arrest this impending danger, it has been proposed that an amount of 64,000,000 bushels of wheat should be purchased by the State and stored in national granaries, not to be opened, except to remedy deterioration of grain, or in view of national disaster rendering starvation imminent. This 64,000,000 bushels would add another fourteen weeks' life to the population; assuming that the ordinary stock had not been drawn on, the wheat in the country would only then be enough to feed the population for twenty-eight weeks.

I do not venture to speak authoritatively on national granaries. The subject has been discussed in the daily press, and the recently published report from the Agricultural Committee on National Wheat Stores brings together all the arguments in favor of this important scheme, together with the difficulties to be faced if it be carried out with necessary completeness.

More hopeful, although difficult and costly, would be the alternative of growing most, if not all, of our own wheat supply here at home in the British Isles. The average yield over the United Kingdom last year was 29.07 bushels per acre, the average for the last eleven years being 29.46. For twelve months we need 240,000,000 bushels of wheat, requiring about 8,250,000 acres of good wheat-growing land, or nearly 13,000 square miles, increasing at the rate of 100 square miles per annum, to render us self-supporting as to bread food. This area is about one-fourth the size of England.

A total area of land in the United Kingdom equal to a plot 110 miles square, of quality and climate sufficient to grow wheat to the extent of 29 bushels per acre, does not seem a hopeless demand.* It is doubtful, however, if this amount of land could be kept under wheat, and the necessary expense of high farming faced, except under the imperious pressure of impending starvation or the stimulus of a national subsidy or permanent high prices. Certainly these 13,000 square miles would not be available under ordinary economic conditions, for much, perhaps all, the land now under barley and oats would not be suitable for wheat. In any case, owing to our cold, damp climate and capricious weather, the wheat crop is hazardous, and for the present our annual deficit of 180,000,000 bushels must be imported. A permanently higher price for wheat is, I fear, a calamity that ere long must be faced. At enhanced prices land now under wheat will be better farmed, and therefore will yield better, thus giving increased production without increased area.

The burning question of to-day is: What can the United Kingdom do to be reasonably safe from starvation in presence of two successive failures of the world's wheat harvest, or against a hostile combination of European nations? We eagerly spend millions

* The total area of the United Kingdom is 120,979 square miles; therefore the required land is about a tenth part of the total.

to protect our coasts and commerce, and millions more on ships, explosives, guns and men; but we omit to take necessary precautions to supply ourselves with the very first and supremely important munition of war—food.

To take up the question of food supply in its scientific aspect, I must not confine myself exclusively to our own national requirements. The problem is not restricted to the British Isles—the bread-eaters of the whole world share the perilous prospect—and I do not think it out of place if on this occasion I ask you to take with me a wide, general survey of the wheat supply of the whole world.

Wheat is the most sustaining food grain of the great Caucasian race, which includes the peoples of Europe, United States, British America, the white inhabitants of South Africa, Australasia, parts of South America, and the white population of the European colonies. Of late years the individual consumption of wheat has almost universally increased. In Scandinavia it has risen 100 per cent. in twenty-five years; in Austro-Hungary, 80 per cent.; in France, 20 per cent.; while in Belgium it has increased 50 per cent. Only in Russia and Italy, and possibly Turkey, has the consumption of wheat per head declined.

In 1871 the bread-eaters of the world numbered 371,000,000. In 1881 the numbers rose to 416,000,000; in 1891, to 472,600,000, and at the present time they number 516,500,000. The augmentation of the world's bread-eating population in a geometrical ratio is evidenced by the fact that the yearly aggregates grow progressively larger. In the early seventies they rose 4,300,000 per annum, while in the eighties they increased by more than 6,000,000 per annum, necessitating annual additions to the bread supply nearly one-half greater than sufficed twenty-five years ago.

How much wheat will be required to supply all these hungry mouths with bread? At the present moment it is not possible to get accurate estimates of this year's wheat crops of the world, but an adequate idea may be gained from the realized crops of some countries and the promise of others. To supply 516,500,000 bread-eaters, if each bread-eating unit is to have his usual ration, will require a total of 2,324,000,000 bushels for seed and food. What are our prospects of obtaining this amount?

According to the best authorities the total supplies from the 1897–98 harvest are 1,921,000,000 bushels. The requirement of the 516,500,000 bread-eaters for seed and food are 2,324,000,000 bushels; there is thus a deficit of 403,000,000 bushels, which has not been urgently apparent owing to a surplus of 300,000,000 bushels carried over from the last harvest. Respecting the prospects of the harvest year just beginning it must be borne in mind that there are no remainders to bring over from last harvest. We start with a deficit of 103,000,000 bushels and have 6,500,000 more mouths to feed. It follows, therefore, that one-sixth of the required bread will be lacking unless larger drafts than now seem possible can be made upon early produce from the next harvest.

The majority of the wheat crops between 1882 and 1896 were in excess of current needs, and thus considerable reserves of wheat were available for supplementing small deficits from the four deficient harvests. But bread-eaters have almost eaten up the reserves of wheat, and, the 1897 harvest being under average, the conditions become serious. That scarcity and high prices have not prevailed in recent years is due to the fact that since 1889 we have had seven world crops of wheat and six of rye abundantly in excess of the average. These generous crops increased accumulations to

such an extent as to obscure the fact that the harvests of 1895 and 1896 were each much below current requirements. Practically speaking, reserves are now exhausted, and bread-eaters must be fed from current harvests, accumulation under present conditions being almost impossible. This is obvious from the fact that a harvest equal to that of 1894 (the greatest crop on record, both in acre-yield and in the aggregate) would yield less than current needs.

It is clear we are confronted with a colossal problem that must tax the wits of the wisest. When the bread-eaters have exhausted all possible supplies from the 1897–98 harvest there will be a deficit of 103,000,000 bushels of wheat, with no substitution possible unless Europeans can be induced to eat Indian corn or rye bread. Up to recent years the growth of wheat has kept pace with demands. As wheat-eaters increased, the acreage under wheat expanded. The world has become so familiarized with the orderly sequence of demand and supply, so accustomed to look upon the vast plains of other wheat-growing countries as inexhaustible granaries, that, in a light hearted way, it is taken for granted that so many million additional acres can be added year after year to the wheat-growing area of the world. We forget that the wheat-growing area is of strictly limited extent, and that a few million acres regularly absorbed soon mount to a formidable number.

The present position being so gloomy, let us consider future prospects. What are the capabilities as regards available area, economic conditions and acreage-yield of the wheat-growing countries from whence we now draw our supply?

For the last thirty years the United States have been the dominant factor in the foreign supply of wheat, exporting no less than 145,000,000 bushels. This shows how the bread-eating world has depended, and still depends, on the United States for the means of subsistence. The entire world's contributions to the food-bearing area have averaged but 4,000,000 acres yearly since 1869. It is scarcely possible that such an average, under existing conditions, can be doubled for the coming twenty-five years. Almost yearly, since 1885, additions to the wheat-growing area have diminished, while the requirements of the increasing population of the States have advanced, so that the needed American supplies have been drawn from the acreage hitherto used for exportation. Practically there remains no uncultivated prairie land in the United States suitable for wheat-growing. The virgin land has been rapidly absorbed, until at present there is no land left for wheat without reducing the area for maize, hay and other necessary crops.

It is almost certain that within a generation the ever-increasing population of the United States will consume all the wheat grown within its borders, and will be driven to import, and, like ourselves, will scramble for a lion's share of the wheat crop of the world. This being the outlook, exports of wheat from the United States are only of present interest, and will gradually diminish to a vanishing point. The inquiry may be restricted to such countries as probably will continue to feed bread-eaters who annually derive a considerable part of their wheat from extraneous sources.

But if the United States, which grows about one-fifth of the world's wheat, and contribute one-third of all wheat exportations, are even now dropping out of the race, and likely soon to enter the list of wheat-importing countries, what prospect is there that other wheat-growing countries will be able to fill the gap, and, by enlarging their acreage under wheat, replace the supply which the States have so long con-

tributed to the world's food? The withdrawal of 145,000,000 bushels will cause a serious gap in the food supply of wheat-importing countries, and unless this deficit can be met by increased supplies from other countries there will be a dearth for the rest of the world after the British Isles are sufficiently supplied.

Next to the United States, Russia is the greatest wheat exporter, supplying nearly 95,000,000 bushels.

Although Russia at present exports so lavishly, this excess is merely provisional and precarious. The Russian peasant population increases more rapidly than any other in Europe. The yield per acre over European Russia is meagre—not more than 8.6 bushels to the acre—while some authorities consider it as low as 4.6 bushels. The cost of production is low—lower even than on the virgin soils of the United States. The development of the fertile though somewhat overrated 'black earth,' which extends across the southern portion of the Empire and beyond the Ural Mountains into Siberia, progresses rapidly. But, as we have indicated, the consumption of bread in Russia has been reduced to danger point. The peasants starve and fall victims to 'hunger typhus,' whilst the wheat growers export grain that ought to be consumed at home.

Considering Siberia as a wheat grower, climate is the first consideration. Summers are short—as they are in all regions with continental climates north of the 45th parallel—and the ripening of wheat requires a temperature averaging at least 65° Fahr. for fifty-five to sixty-five days. As all Siberia lies north of the summer isotherm of 65°, it follows that such region is ill adapted to wheat culture unless some compensating climatic condition exists. As a fact, the conditions are exceptionally unfavorable in all but very limited districts in the two westernmost governments. The cultivatable lands of western Siberia adapted to grain-bearing equal neither in extent nor in potential productive powers those of Iowa, Minnesota and Nebraska. There are limited tracts of fair productiveness in central Siberia and in the valleys of the southern affluents of the Amoor, but these are only just capable of supporting a meager population.

Prince Hilkoff, Russian Minister of Ways and Communications, declared in 1896 that "Siberia never had produced, and never would produce, wheat and rye enough to feed the Siberian population." And, a year later, Prince Krapotkin backed the statement as substantially correct.

Those who attended the meeting of the British Association last year in Canada must have been struck with the extent and marvellous capacity of the fertile plains of Manitoba and the Northwest Provinces. Here were to be seen 1,290,000 acres of fine wheat-growing land yielding 18,261,950 bushels, one-fifth of which comes to hungry England. Expectations have been cherished that the Canadian Northwest would easily supply the world with wheat, and exaggerated estimates are drawn as to the amount of surplus land on which wheat can be grown. Thus far performance has lagged behind promise, the wheat-bearing area of all Canada having increased less than 500,000 acres since 1884, while the exports have not increased in greater proportion. As the wheat area of Manitoba and the Northwest has increased, the wheat area of Ontario and the Eastern Provinces has decreased, the added acres being little more than sufficient to meet the growing requirements of population. We have seen calculations showing that Canada contains 500,000,000 acres of profitable wheat land. The impossibility of such an estimate ever being fulfilled will be apparent when it is remembered that the whole area employed in both

temperate zones for growing all the stable food crops is not more than 580,000,000 acres, and that in no country has more than 9 per cent. of the area been devoted to wheat culture.

The fertility of the Northwest Provinces of the Dominion is due to an exceptional and curious circumstance. In winter the ground freezes to a considerable depth. Wheat is sown in the spring, generally in April, when the frozen ground has been thawed to a depth of three inches. Under the hot sun of the short summer the grain sprouts with surprising rapidity, partly because the roots are supplied with water from the thawing depths. The summer is too short to thaw the ground thoroughly, and gate-posts or other dead wood extracted in autumn are found still frozen at their lower end.

Australasia, as a potential contributor to the world's supply of wheat, affords another fertile field for speculation. Climatic conditions limit the Australian wheat area to a small portion of the southern littoral belt. Professor Shelton considers there are still fifty million acres in Queensland suitable for wheat, but hitherto it has never had more than 150,000 acres under cultivation. Crops in former days were liable to rust, but, since the Rust in Wheat, conferences, and the dissemination of instruction to farmers, rust no longer has any terrors. I am informed by the Queensland Department of Agriculture that of late years they have practically bred wheat vigorous enough to resist this plague. For the second season in succession the wheat crop last year was destroyed over large areas in Victoria; and in South Australia the harvest averaged not more than about $3\frac{3}{4}$ bushels per acre after meeting Colonial requirements for food and seed, leaving only 684,000 bushels for export. In most other districts the yield falls to such an extent as to cause Europeans to wonder why the pursuit of wheat-raising is continued.

New Zealand has a moist climate resembling that of central and southern England, while South Australia is semi-arid, resembling western Kansas. Only two countries in the world yield as much wheat per acre as New Zealand; these are Denmark and the United Kingdom. Notwithstanding the great yield of wheat, due to an equable climate, New Zealand finds fruit and dairy farming still more profitable. The climatic conditions favorable to wheat are also conducive to luxuriant growths of nutritious grasses. Thus the New Zealander ships his butter more than half way round the world, and competes successfully with western Europe.

During the last twenty-seven years the Austro-Hungarian population has increased 21.8 per cent., as against an increase of 54.6 per cent. in the acreage of wheat. Notwithstanding this disparity in the rates of increase, exports have practically ceased by reason of an advance of nearly 80 per cent. in unit consumption. There can be little doubt that Austro-Hungary is about to enter the ranks of importing nations, although in Hungary a considerable area of wheat land remains to be brought under cultivation.

Roumania is an important wheat-growing country. In 1896 it produced 69,000,000 bushels and exported 34,000,000 bushels. It has a considerable amount of surplus land which can be used for wheat, although for many years the wheat area is not likely to exceed home requirements.

France comes next to the United States as a producer of wheat; but for our purpose she counts but little, being dependent on supplies from abroad for an average quantity of 14 per cent. of her own production. There is practically no spare land in France that can be put under wheat in sufficient

quantity to enable her to do more than provide for increase of population.

Germany is a gigantic importer of wheat, her imports rising 700 per cent. in the last twenty-five years, and now averaging 35,000,000 bushels. Other nations of Europe, also importers, do not require detailed mention, as under no conceivable conditions would they be able to do more than supply wheat for the increasing requirements of their local population, and, instead of replenishing, would probably diminish, the world's stores.

The prospective supply of wheat from Argentina and Uruguay has been greatly overrated. The agricultural area includes less than 100,000,000 acres of good, bad and indifferent land, much of which is best adapted for pastoral purposes. There is no prospect of Argentina ever being able to devote more than 30,000,000 acres to wheat; the present wheat area is about 6,000,000 acres, an area that may be doubled in the next twelve years. But the whole arable region is subject to great climatic vicissitudes and to frosts that ravage the fields south of the thirty-seventh parallel. Years of systematized energy are frustrated in a few days—perhaps hours—by a single cruelty of Nature, such as a plague of locusts, a tropical rain or a devastating hail storm. It will take years to bring the surplus lands of Argentina into cultivation, and the population is even now insufficient to supply labor at seed time and harvest.

During the next twelve years Uruguay may add a million acres to the world's wheat fields; but social, political and economic conditions seriously interfere with agricultural development.

At the present time South Africa is an importer of wheat, and the regions suitable to cereals do not exceed a few million acres. Great expectations have been formed as to the fertility of Mashonaland, the Shire Highlands and the Kikuyu plateau, and as to the adaptation of these regions to the growth of wheat. But wheat culture fails where the banana ripens, and the banana flourishes throughout Central Africa, except in limited areas of great elevation. In many parts of Africa insect pests render it impossible to store grain, and without grain-stores there can be little hope of large exports.

North Africa, formerly the granary of Rome, now exports less than 5,000,000 bushels of wheat annually, and these exports are on the decline, owing to increased home demands. With scientific irrigation, Egypt could supply three times her present amount of wheat, although no increase is likely unless the cotton fields of the Delta are diverted to grain growing. In Algeria and Tunis nearly all reclaimed lands are devoted to the production of wine, for which a brisk demand exists. Were this land devoted to the growth of wheat an additional five million bushels might be obtained.

The enormous acreage devoted to wheat in India has been declining for some years, and in 1895 over 20,000,000 acres yielded 185,000,000 bushels. Seven-eighths of this harvest is required for native consumption, and only one-eighth on an average is available for export. The annual increase of population is more than 3,000,000, demanding an addition to the food-bearing lands of not less than 1,800,000 acres annually. In recent years the increase has been less than one-fourth of this amount.

In surveying the limitations and vicissitudes of wheat crops, I have endeavored to keep free from exaggeration, and have avoided insistence on doubtful points. I have done my best to get trustworthy facts and figures, but from the nature of the case it is impossible to attain complete accuracy. Great caution is required in sifting the numerous varying current statements respect-

ing the estimated areas and total produce of wheat throughout the world. The more closely official estimates are examined, the more defective are they found, and comparatively few figures are sufficiently well established to bear the deductions often drawn. In doubtful cases I have applied to the highest authorities in each country, and in the case of conflicting accounts have taken data the least favorable to sensational or panic-engendering statements. In a few instances of accurate statistics their value is impaired by age; but for 95 per cent. of my figures I quote good authorities, while for the remaining 5 per cent. I rely on the best commercial estimates derived from the appearance of the growing crops, the acreage under cultivation and the yield last year. The maximum probable error would make no appreciable difference in my argument.

The facts and figures I have set before you are easily interpreted. Since 1871 unit consumption of wheat, including seed, has slowly increased in the United Kingdom to the present amount of six bushels per head per annum; while the rate of consumption for seed and food by the whole world of bread-eaters was 4.15 bushels per unit per annum for the eight years ending 1878, and at the present time is 4.5 bushels. Under present conditions of low acre yield, wheat cannot long retain its dominant position among the food-stuffs of the civilized world. The details of the impending catastrophe no one can predict, but its general direction is obvious enough. Should all the wheat-growing countries add to their area to the utmost capacity, on the most careful calculation the yield would give us only an addition of some 100,000,000 acres, supplying at the average world-yield of 12.7 bushels to the acre, 1,270,000,000 bushels, just enough to supply the increase of population among bread-eaters till the year 1931.

At the present time there exists a deficit in the wheat area of 31,000 square miles—a deficit masked by the fact that the ten world crops of wheat harvested in the ten years ending 1896 were more than 5 per cent. above the average of the previous twenty-six years.

When provision shall have been made, if possible, to feed 230,000,000 units likely to be added to the bread-eating populations by 1931—by the complete occupancy of the arable areas of the temperate zone now partially occupied—where can be grown the additional 330,000,000 bushels of wheat required ten years later by a hungry world? What is to happen if the present rate of population be maintained, and if arable areas of sufficient extent cannot be adapted and made contributory to the subsistence of so great a host.

Are we to go hungry and to know the trial of scarcity? That is the poignant question. Thirty years is but a day in the life of a nation. Those present who may attend the meeting of the British Association thirty years hence will judge how far my forecasts are justified.

If bread fails—not only us, but all the bread-eaters of the world—what are we to do? We are born wheat-eaters. Other races, vastly superior to us in numbers, but differing widely in material and intellectual progress, are eaters of Indian corn, rice, millet and other grains; but none of these grains have the food value, the concentrated health-sustaining power of wheat, and it is on this account that the accumulated experience of civilized mankind has set wheat apart as the fit and proper food for the development of muscle and brains.

It is said that when other wheat-exporting countries realize that the States can no longer keep pace with the demand, these countries will extend their area of cultivation, and struggle to keep up the supply *pari passu* with the falling off in other quarters. But will this comfortable and cher-

ished doctrine bear the test of examination?

Cheap production of wheat depends on a variety of causes, varying greatly in different countries. Taking the cost of producing a given quantity of wheat in the United Kingdom at 100s., the cost for the same amount in the United States is 67s., in India 66s., and in Russia 54s. We require cheap labor, fertile soil, easy transportation to market, low taxation and rent, and no export or import duties. Labor will rise in price, and fertility diminish as the requisite manurial constituents in the virgin soil become exhausted. Facility of transportation to market will be aided by railways, but these are slow and costly to construct, and it will not pay to carry wheat by rail beyond a certain distance. These considerations show that the price of wheat tends to increase. On the other hand, the artificial impediments of taxation and customs duties tend to diminish as demand increases and prices rise.

I have said that starvation may be averted through the laboratory. Before we are in the grip of actual dearth the chemist will step in and postpone the day of famine to so distant a period that we and our sons and grandsons may legitimately live without undue solicitude for the future.

It is now recognized that all crops require what is called a 'dominant' manure. Some need nitrogen, some potash, others phosphates. Wheat preeminently demands nitrogen, fixed in the form of ammonia or nitric acid. All other necessary constituents exist in the soil; but nitrogen is mainly of atmospheric origin, and is rendered 'fixed' by a slow and precarious process which requires a combination of rare meteorological and geographical conditions to enable it to advance at a sufficiently rapid rate to become of commercial importance.

There are several sources of available nitrogen. The distillation of coal in the process of gas-making yields a certain amount of its nitrogen in the form of ammonia; and this product, as sulphate of ammonia, is a substance of considerable commercial value to gas companies. But the quantity produced is comparatively small; all Europe does not yield more than 400,000 annual tons, and, in view of the unlimited nitrogen required to substantially increase the world's wheat crop, this slight amount of coal ammonia is not of much significance. For a long time guano has been one of the most important sources of nitrogenous manures, but guano deposits are so near exhaustion that they may be dismissed from consideration.

Much has been said of late years, and many hopes raised by the discovery of Hellriegel and Wilfarth, that leguminous plants bear on their roots nodosities abounding in bacteria endowed with the property of fixing atmospheric nitrogen; and it is proposed that the necessary amount of nitrogen demanded by grain crops should be supplied to the soil by cropping it with clover and ploughing in the plant when its nitrogen assimilization is complete. But it is questionable whether such a mode of procedure will lead to the lucrative stimulation of crops. It must be admitted that practice has long been ahead of science, and for ages farmers have valued and cultivated leguminous crops. The four-course rotation is turnips, barley, clover, wheat—a sequence popular more than two thousand years ago. On the Continent, in certain localities, there has been some extension of microbe cultivation; at home we have not reached even the experimental stage. Our present knowledge leads to the conclusion that the much more frequent growth of clover on the same land, even with successful microbe-seeding and proper mineral supplies, would be attended with uncer-

tainty and difficulties. The land soon becomes what is called 'clover sick' and turns barren.

There is still another and invaluable source of fixed nitrogen. I mean the treasure locked up in the sewage and drainage of our towns. Individually the amount so lost is trifling, but multiply the loss by the number of inhabitants, and we have the startling fact that, in the United Kingdom, we are content to hurry down our drains and water courses, into the sea, fixed nitrogen to the value of no less than 16,000,000*l.* per annum. This unspeakable waste continues, and no effective and universal method is yet contrived of converting sewage into corn. Of this barbaric waste of manurial constituents Liebig, nearly half a century ago, wrote in these prophetic words: "Nothing will more certainly consummate the ruin of England than a scarcity of fertilizers—it means a scarcity of food. It is impossible that such a sinful violation of the divine laws of Nature should forever remain unpunished; and the time will probably come for England sooner than for any other country when, with all her wealth in gold, iron and coal, she will be unable to buy one-thousandth part of the food which she has, during hundreds of years, thrown recklessly away."

The more widely this wasteful system is extended, recklessly returning to the sea what we have taken from the land, the more surely and quickly will the finite stocks of nitrogen locked up in the soils of the world become exhausted. Let us remember that the plant creates nothing; there is nothing in bread which is not absorbed from the soil, and, unless the abstracted nitrogen is returned to the soil, its fertility must ultimately be exhausted. When we apply to the land nitrate of soda, sulphate of ammonia or guano we are drawing on the earth's capital, and our drafts will not perpetually be honored. Already we see that a virgin soil cropped for several years loses its productive powers, and without artificial aid becomes infertile. Thus the strain to meet demands is increasingly great. Witness the yield of forty bushels of wheat per acre under favorable conditions, dwindling through exhaustion of soil to less than seven bushels of poor grain, and the urgency of husbanding the limited store of fixed nitrogen becomes apparent. The store of nitrogen in the atmosphere is practically unlimited, but it is fixed and rendered assimilable by plants only by cosmic processes of extreme slowness. The nitrogen which, with a light heart, we liberate in a battleship broadside has taken millions of minute organisms patiently working for centuries to win from the atmosphere.

The only available compound containing sufficient fixed nitrogen to be used on a world-wide scale as a nitrogenous manure is nitrate of soda, or Chili saltpetre. This substance occurs native over a narrow band of the plain of Tamarugal, in the northern provinces of Chili, between the Andes and the coast hills. In this rainless district, for countless ages, the continuous fixation of atmospheric nitrogen by the soil, its conversion into nitrate by the slow transformation of billions of nitrifying organisms, its combination with soda, and the crystallization of the nitrate, have been steadily proceeding, until the nitrate fields of Chili have become of vast commercial importance, and promise to be of inestimably greater value in the future. The growing exports of nitrate from Chili at present amount to about 1,200,000 tons.

The present acreage devoted to the world's growth of wheat is about 163,000,000 acres. At the average of 12.7 bushels per acre this gives 2,070,000,000 bushels. But thirty years hence the demand will be 3,260,000,000 bushels, and there will be difficulty in finding the necessary acreage

on which to grow the aditional amount required. By increasing the present yield per acre from 12.7 to 20 bushels we should, with our present acreage, secure a crop of the requisite amount. Now from 12.7 to 20 bushels per acre is a moderate increase of productiveness, and there is no doubt that a dressing with nitrate of soda will give this increase and more.

The action of nitrate of soda in improving the yield of wheat has been studied practically by Sir John Lawes and Sir Henry Gilbert on their experimental field at Rothamstead. This field was sown with wheat for thirteen consecutive years without manure, and yielded an average of 11.9 bushels to the acre. For the next thirteen years it was sown with wheat, and dressed with 5 cwt. of nitrate of soda per acre, other mineral constituents also being present. The average yield for these years was 36.4 bushels per acre—an increase of 24.5 bushels. In other words, 22.86 pounds of nitrate of soda produce an increase of one bushel of wheat.

At this rate, to increase the world's crop of wheat by 7.3 bushels, about $1\frac{1}{2}$ cwt. of nitrate of soda must annually be applied to each acre. The amount required to raise the world's crop on 163,000,000 acres from the present supply of 2,070,000,000 bushels to the required 3,260,000,000 bushels will be 12,000,000 tons, distributed in varying amounts over the wheat-growing countries of the world. The countries which produce more than the average of 12.7 bushels will require less, and those below the average will require more; but, broadly speaking, about 12,000,000 tons annually of nitrate of soda will be required, in addition to the 1,250,000 tons already absorbed by the world.

It is difficult to get trustworthy estimates of the amount of nitrate surviving in the nitre beds. Common rumor declares the supply to be inexhaustible, but cautious local authorities state that at the present rate of export, of over 1,000,000 tons per annum, the raw material 'caliche,' containing from 25 to 50 per cent. nitrate, will be exhausted in from twenty to thirty years.

Dr. Newton, who has spent years on the nitrate fields, tells me there is a lower class material, containing a small proportion of nitrate, which cannot at present be used, but which may ultimately be manufactured at a profit. Apart from a few of the more scientific manufacturers, no one is sanguine enough to think this debatable material will ever be worth working. If we assume a liberal estimate for nitrate obtained from the lower grade deposit, and say that it will equal in quantity that from the richer quality, the supply may last, possibly, fifty years, at the rate of a million tons a year; but at the rate required to augment the world's supply of wheat to the point demanded thirty years hence it will not last more than four years.

I have passed in review all the wheat-growing countries of the world, with the exception of those whose united supplies are so small as to make little appreciable difference to the argument. The situation may be summed up briefly thus: The world's demand for wheat—the leading bread-stuff—increases in a crescendo ratio year by year. Gradually all the wheat-bearing land on the globe is appropriated to wheat-growing, until we are within measurable distance of using the last available acre. We must then rely on nitrogenous manures to increase the fertility of the land under wheat, so as to raise the yield from the world's low average—12.7 bushels per acre—to a higher average. To do this efficiently and feed the bread-eaters for a few years will exhaust all the available store of nitrate of soda. For years past we have been spending fixed nitrogen at a culpably extravagant rate, heedless of the fact that it is fixed with extreme slow-

ness and difficulty, while its liberation in the free state takes place always with rapidity and sometimes with explosive violence.

Some years ago Mr. Stanley Jevons uttered a note of warning as to the near exhaustion of our British coalfields. But the exhaustion of the world's stock of fixed nitrogen is a matter of far greater importance. It means not only a catastrophe little short of starvation for the wheat-eaters, but indirectly, scarcity for those who exist on inferior grains, together with a lower standard of living for meat-eaters, scarcity of mutton and beef, and even the extinction of gunpowder!

There is a gleam of light amid this darkness of despondency. In its free state nitrogen is one of the most abundant and pervading bodies on the face of the earth. Every square yard of the earth's surface has nitrogen gas pressing down on it to the extent of about seven tons; but this is in the *free* state, and wheat demands it *fixed*. To convey this idea in an object-lesson, I may tell you that, previous to its destruction by fire, Colston Hall, measuring 146 feet by 80 feet by 70 feet, contained 27 tons' weight of nitrogen in its atmosphere; it also contained one-third of a ton of argon. In the free gaseous state this nitrogen is worthless; combined in the form of nitrate of soda it would be worth about 2,000*l*.

For years past attempts have been made to effect the fixation of atmospheric nitrogen, and some of the processes have met with sufficient partial success to warrant experimentalists in pushing their trials still further; but I think I am right in saying that no process has yet been brought to the notice of scientific or commercial men which can be considered successful either as regards cost or yield of product. It is possible, by several methods, to fix a certain amount of atmospheric nitrogen; but, to the best of my knowledge, no process has hitherto converted more than a small amount, and this at a cost largely in excess of the present market value of fixed nitrogen.

The fixation of atmospheric nitrogen, therefore, is one of the great discoveries awaiting the ingenuity of chemists. It is certainly deeply important in its practical bearings on the future welfare and happiness of the civilized races of mankind. This unfulfilled problem, which so far has eluded the strenuous attempts of those who have tried to wrest the secret from Nature, differs materially from other chemical discoveries which are in the air, so to speak, but are not yet matured. The fixation of nitrogen is vital to the progress of civilized humanity. Other discoveries minister to our increased intellectual comfort, luxury or convenience; they serve to make life easier, to hasten the acquisition of wealth, or to save time, health or worry. The fixation of nitrogen is a question of the not-far-distant future. Unless we can class it among certainties to come, the great Caucasian race will cease to be foremost in the world, and will be squeezed out of existence by races to whom wheaten bread is not the staff of life.

Let me see if it is not possible even now to solve the momentous problem. As far back as 1892 I exhibited, at one of the Soirées of the Royal Society, an experiment on 'The Flame of Burning Nitrogen.' I showed that nitrogen is a combustible gas, and the reason why when once ignited the flame does not spread through the atmosphere and deluge the world in a sea of nitric acid is that its igniting point is higher than the temperature of its flame—not, therefore, hot enough to set fire to the adjacent mixture. But by passing a strong induction current between terminals the air takes fire and continues to burn with a powerful flame, producing nitrous and nitric acids. This inconsiderable experiment may not unlikely lead to the development of a mighty industry destined to solve the great

food problem. With the object of burning out nitrogen from air so as to leave argon behind, Lord Rayleigh fitted up apparatus for performing the operation on a larger scale, and succeeded in effecting the union of 29.4 grams of mixed nitrogen and oxygen at an expenditure of one horse-power. Following these figures it would require one Board of Trade unit to form 74 grams of nitrate of soda, and therefore 14,000 units to form one ton. To generate electricity in the ordinary way with steam engines and dynamos, it is now possible, with a steady load night and day, and engines working at maximum efficiency, to produce current at a cost of one-third of a penny per Board of Trade unit. At this rate one ton of nitrate of soda would cost 26*l.* But electricity from coal and steam engines is too costly for large industrial purposes; at Niagara, where water power is used, electricity can be sold at a profit for one-seventeenth of a penny per Board of Trade unit. At this rate nitrate of soda would cost not more than 5*l.* per ton. But the limit of cost is not yet reached, and it must be remembered that the initial data are derived from small-scale experiments, in which the object was not economy, but rather to demonstrate the practicability of the combustion method and to utilize it for isolating argon. Even now electric nitrate at 5*l.* a ton compares favorably with Chili nitrate at 7*l.* 10*s.* a ton, and all experience shows that when the road has been pointed out by a small laboratory experiment the industrial operations that may follow are always conducted at a cost considerably lower than could be anticipated from the laboratory figures.

Before we decide that electric nitrate is a commercial possibility a final question must be mooted. We are dealing with wholesale figures, and must take care that we are not simply shifting difficulties a little further back without really diminishing them. We start with a shortage of wheat, and the natural remedy is to put more land under cultivation. As the land cannot be stretched, and there is so much of it and no more, the object is to render the available area more productive by a dressing with nitrate of soda. But nitrate of soda is limited in quantity and will soon be exhausted. Human ingenuity can contend even with these apparently hopeless difficulties. Nitrate can be produced artificially by the combustion of the atmosphere. Here we come to finality in one direction; our stores are inexhaustible. But how about electricity? Can we generate enough energy to produce 12,000,000 tons of nitrate of soda annually? A preliminary calculation shows that there need be no fear on that score; Niagara alone is capable of supplying the required electric energy without much lessening its mighty flow.

The future can take care of itself. The artificial production of nitrate is clearly within view, and by its aid the land devoted to wheat can be brought up to the thirty-bushels-per-acre standard. In days to come, when the demand may again overtake supply, we may safely leave our successors to grapple with the stupendous food problem.

And, in the next generation, instead of trusting mainly to food-stuffs which flourish in temperate climates, we probably shall trust more and more to the exuberant food-stuffs of the tropics, where, instead of one yearly sober harvest, jeopardized by any shrinkage of the scanty days of summer weather, or of the few steady inches of rainfall, Nature annually supplies heat and water enough to ripen two or three successive crops of food-stuffs in extraordinary abundance. To mention one plant alone, Humboldt—from what precise statistics I know not—computed that, acre for acre, the food-productiveness of the banana is 133 times that of wheat; the unripe banana, before its starch is converted into sugar, is said to make excellent bread.

Considerations like these must in the end determine the range and avenues of commerce, perhaps the fate of continents. We must develop and guide Nature's latent energies; we must utilize her inmost workshops; we must call into commercial existence Central Africa and Brazil to redress the balance of Odessa and Chicago.

WILLIAM CROOKES.

(To be concluded.)

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*VARIATIONS IN THE RATE OF AGRICULTURAL PRODUCTION AND ONE OF THEIR CAUSES.**

THE twenty years ending with 1897 witnessed the harvesting in the United States of crops of corn, oats and rye, the yield per acre of which was from 50 to 60 per cent greater than the corresponding yield in certain other years of the same period; of crops of potatoes in which it was from 80 to 87 per cent greater than in other years of the period under consideration, and of crops of buckwheat in which it was from 80 to 130 per cent greater than in the case of certain other crops of buckwheat grown within this same period of twenty years. On the other hand, the highest annual yields per acre of wheat, cotton, hay, barley and tobacco were only 50, 39, 39, 36 and 23 per cent, respectively, higher than the lowest. This remarkable non-uniformity of fluctuation has suggested to the author of this paper the operation of some law not hitherto generally recognized, and the examination of the statistics of a large number of crops for each separate state during a period of twenty years shows that, entirely independently of whether the average yield per acre be high or low, the nearer the approach to the region to which a product is indigenous the more uniform will be the rate of production from year to year, and the further the departure from such region the greater the liability to fluctuation.

For the purpose of this abstract, four products only need be considered: oats, barley, cotton and corn. The period covered is twenty years, 1878–97, and the comparison is based in each case—not upon the two extreme deviations, but on the means of the three highest and the three lowest yields per acre in the twenty-year period, the figures given representing the per cent of the deviation of these means from the mean of the entire period.

In the case of oats in 12 of the most northerly states of the Union (the Transition zone* of the Merriam Life Zone Map) the deviation from the twenty-year average was only 34.23 per cent, only 2 states exceeding 40 per cent; in the Upper Austral (from New Jersey, Delaware and Maryland to Kansas and Nebraska) the deviation was 53.95 per cent, only one state having less than 40 per cent, and in the Lower Austral (from Virginia, the Carolinas and Georgia to Texas and Arkansas) it was 62.78 per cent, no state falling below 50 per cent. In the case of barley the deviation in the Transition zone was 37.7 per cent, in the Upper Austral 59.5 per cent, and in the Lower Austral 69.9 per cent.

On the other hand, in the case of corn and cotton it is with the extension of their cultivation northward that the range of fluctuation in the average rate of production is found to increase. In the case of cotton this variation was 25.1 per cent of the average yield per acre in Alabama, 26.3 per cent in Georgia, 35 per cent in Mississippi, 37.9 per cent in South Carolina, 40.4 per cent in Louisiana, 41.3 per cent in North Carolina, 42 per cent in Arkansas, 53 per cent in Texas,† 54 per cent in Vir-

* Abstract of paper read before Section I—Social and Economic Science—of the American Association for the Advancement of Science, August, 1898.

* The transcontinental belt in which Boreal and Austral elements overlap.

† The somewhat wide fluctuation in Texas is due to the extension of cotton planting into regions of uncertain rainfall.

ginia, 55.5 per cent in Florida,* and 75.3 per cent in Tennessee.

Corn does not exhibit the same regularity of progression, owing (1) to the large acreage in the semi-arid portions of Texas, Kansas and Nebraska, where the frequent deficiency of moisture is a disturbing element; (2) to the extent to which special varieties have been adapted to local conditions to meet a want that no other crop can satisfactorily supply, and (3) to the extreme care with which this greatly esteemed product is cultivated in certain sections where its growth is precarious.† Still, the variation in the Upper Austral zone, excluding Kansas and Nebraska,‡ is 49.69 per cent, against 38.46 per cent in the Lower Austral, exclusive of Texas;‡ and if, for the reasons above stated, that of the most northerly tier of states, excluding Maine and Rhode Island,‡ is only 44.57 per cent, it is a significant fact that there is not a state in this belt with as small a variation as Alabama or Florida, and that there is but one that will compare favorably with Georgia, Mississippi, Louisiana or Tennessee.

Investigations show that this law of diminishing constancy is entirely independent of whether the average yield per acre is high or low, and that there is no general correspondence between its operation and the annual variation in the rainfall. The non-uniformity in the fluctuations of various products is attributed by the author to the different proportions of such products grown at a greater or less distance from the natural habitat.

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* Not altogether reliable, owing to the non-determinable proportions of the upland and sea-island varieties.

† Although corn is essentially a tropical plant, the highest average yields per acre in this country are those of the New England States. While the high cultivation to which this is due has a steadying effect upon the rate of production from year to year, that rate of production is by no means so uniform as in the States bordering on the Gulf of Mexico, Texas excepted.

‡ The reasons for these exclusions are fully stated in the paper from which this brief abstract is taken.

ON THE REAPPEARANCE OF THE TILE-FISH.
(LOPHOLATILUS CHAMÆLEONTICEPS.)

DURING March and April, 1882, the presence on the surface of the ocean of large numbers of dead tile-fish gave rise to considerable discussion in scientific journals, and frequent allusions have since been made in text-books, and elsewhere, to this phenomenon as illustrating the elimination of a species in recent times by purely natural agents. The reappearance of the fish in abundance in its original locality is, therefore, of considerable biological interest.

The history of the discovery, the 'extinction' and reappearance is as follows:

In May, 1879, Captain Kirby, of Gloucester, caught a great number of tile-fish off the southern coast of Nantucket, in water about 150 fathoms in depth. Specimens were sent to Washington and the species was described by Goode and Bean in the 'Proceedings of the U. S. National Museum' for that year. In July, Captain Dempsey, also of Gloucester, found several specimens in practically the same locality.

In 1880 Professor Baird sent the 'Mary Potter' to search for the fish, but the expedition, on account of uncommonly severe weather, was not successful. The 'Fish Hawk,' however, while exploring along the continental plateau, caught several specimens.

In 1881 the 'Fish Hawk,' continuing deep-sea work along the southern shore of New England, caught a large number, and Professor Baird felt confident that he was about to establish a new industry.

In March and April, 1882, vessels entering New York and other Atlantic ports reported that they had passed through

countless numbers of dead fish while crossing the northern edge of the Gulf Stream. Investigation proved that these were tile-fish, and that they appeared on the surface of the water for an extent of 170 miles in length and 25 miles in width. A conservative estimate, made by Captain J. W. Collins, placed their number at upwards of 1,438,720,000. Allowing ten pounds to each fish, there would be 288 pounds of fish for every man, woman and child then in the United States. In September, Professor Baird chartered the 'Josie Reeves' and sent her to the tile-fish grounds, that he might ascertain to what extent the species had been depleted; but the vessel returned without having found a single individual.

In 1883 the 'Albatross' made further search, but without success.

In 1884 the 'Albatross' made a more careful investigation, but again without success.

In 1885 the same vessel searched from Newfoundland to the Gulf of Mexico without discovering the least trace of the Tile-fish, though *Munida*, a species of Crustacean upon which the fish was known to have fed, was found in abundance.

In 1886, 1887, 1888, 1889, 1890 and 1891 nothing new was learned.

In 1892 Commissioner McDonald fitted out the 'Grampus,' and on August 5th trawls were set on the old tile-fish ground. No fish were taken. On the 6th the trawls were set again, and one specimen weighing seven pounds was brought to the surface. This was the first specimen that had been seen since the mortality of 1882, ten years before. The 'Grampus' continued her work, and in about two weeks caught a second specimen which weighed thirteen pounds. On September 17th one specimen was caught, and on September 18th three specimens were taken. No more were caught until October 8th, when two were found off the Delaware coast. Thus, in 1892, a search of two months yielded only eight specimens.

In 1893 the 'Grampus' resumed the search throughout the months of July, August and September and caught scattering specimens.

During 1894, 1895 and 1896 no additional information relative to the fish was secured.

On February 8, 1897, the Schooner 'Mabel Kenniston,' of Gloucester, was overtaken by a gale on George's Bank and blown 120 miles toward the southwest. After the gale, trawls were set in sixty-five fathoms of water, and thirty tile-fish were caught. These weighed from six to fifteen pounds each. They were landed at Gloucester on February 16th.

On August 12th, of the present year, the 'Grampus' left Woods Holl with a small party of scientific men, and sailed to a point about seventy miles south of No Man's Land. At the first set of the trawl, eight beautiful tile-fish were taken. The boat, insufficiently equipped with lines and bait, at once returned to the 'Station.' New trawls were purchased and on August 30th, ice and bait having been taken on at Newport, she again sailed south. The following morning, when the boat was only sixty miles from Block Island, the trawls were set. The first haul yielded seven fish; the second, forty-seven, and the third, nineteen. On the following day seventy-eight fish were taken, many of them of large size, and the vessel, now bearing 1,000 pounds, headed for Montauk Point, where the fish were given to the soldiers at Camp Wikoff.

When one considers that the trawls were short, provided with only a few hooks and tended by only one dory, it would seem that the fish are sufficiently abundant for an ordinarily equipped fishing-smack, with its miles of trawls, to secure a full fare in a very short time.

The tile-fish, since the mortality of 1882,

has been taken only along the edge of the continental plateau, in water near the one-hundred-fathom line, from points south of No Man's Land, Block Island and the eastern portion of Long Island. The 'range' of the species, as at present determined, is restricted to a tract of the sea bottom about one hundred and fifty miles in length, and ten to fifteen miles in width. The 'stations,' however, are few, and further investigation may result in a considerable extension of the range. The fish that have been caught during the past summer differ in respect to size from those that were caught before the mortality; for, while many are large, weighing fully twenty pounds, there are also many small immature individuals which often weigh but a pound or two. This percentage of immature fish would seem to indicate that the present environmental conditions are favorable, and that the species has become re-established.

H. C. Bumpus,
Director of Biological Laboratory.
U. S. F. C. Station, Woods Holl.

Note—The Grampus again visited the tile-fish grounds the latter part of September, returning to Woods Holl on October 2d, with over two hundred and three fish, weighing upwards of 3,000 pounds. This last catch was made between the meridians of 69 and 70 west longitude, a tract that has not heretofore been known to be occupied by the fish, and indicates an eastern extension of the range of about twenty-five miles.—H. C. B.

SERIATION CURVES OF THE CEPHALIC INDEX.

As a contributor to the discussion of the problems of 'type' and 'variation,' few sciences can offer a more comprehensive data for analysis than physical anthropology. Especially during the last ten years the number of observations available, based upon the study of European populations, has become very large. As late as 1885 the most considerable cranial series which Topinard* could muster were those of Ranke for the Bavarians and of Broca for the Parisians respectively. These, numbering one thousand each, were at that time considered extraordinarily comprehensive. Yet, since the development of the younger school of anthropologists, whose leading principle has been to confine their measurements to the most simple alone, but to extend the number of individuals to a maximum, series of far greater range are possible. Interest in cephalic rather than cranial measurements, the living specimens being limited in number only by the endurance of the observer, has contributed greatly to this result. An analysis of a few seriation curves based upon such observations is not without importance even outside the limits of those interested in physical anthropology alone. Methods and principles are involved which apply to every branch of physical science, from astronomy to psychology.†

There is another imperative reason for calling attention to the significance of these seriation curves of cephalic observations. They are a most conclusive refutation of the statement, which reappears from time to time among those who do not consider the statistical aspects of physical anthropology, that the cephalic index measuring the proportions of the head is devoid of ethnic significance. Confused by the phenomena of individual variation, these critics lose sight of the value, when properly

* Éléments d' anthropologie, pp. 387 *et seq.*

† The best technical discussion of such curves among anthropologists will be found in Goldstein, 1883; Stieda, 1883; Ammon, 1893 and 1896c; Livi, 1895 and 1896a, pp. 22 *et seq.* Dr. Boas has contributed excellent material, based upon the American Indians for the most part. Full titles of all these papers will be found in our Bibliography of the Anthropology and Ethnology of Europe; which, after more than a year of preparation, is shortly to be issued as a special bulletin by the public library of the city of Boston.

treated, of an ethnic criterion which is acknowledged by all the leading authorities of Europe to be of the utmost value. Still another objection to the use of the cephalic index as a racial criterion, even from some of its best friends, seems to be answered by the study of such curves. It is maintained that the cephalic index is not an objective *reality*, but merely a *relation* of the length of the head to its breadth. This is, indeed, would be absurd to maintain it. Surely it is the *relativity* in length of the leg bones compared with spinal column. If such a *relation*, then, of the length of the head to its breadth be not a fit subject for detailed analysis our curves certainly belie it.

Seriation curves drawn for the cephalic index are entirely similar to the more familiar ones based upon observations of stature.* The same principles underlie

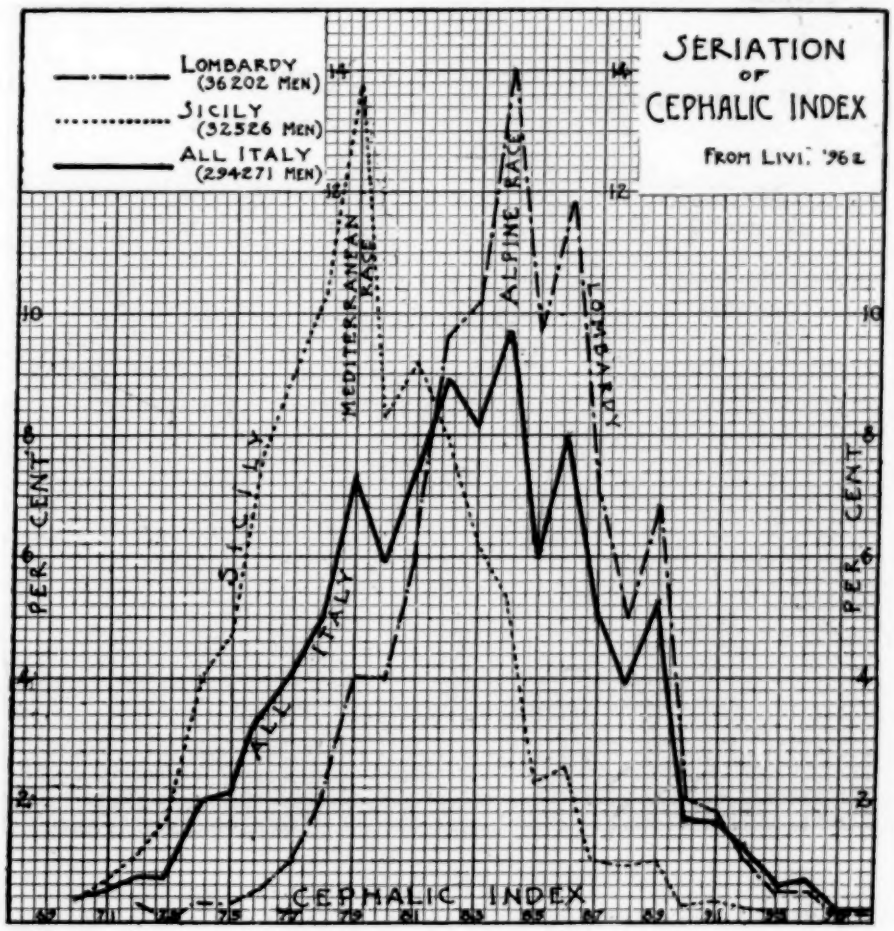

FIG. 1.

true. Yet how about nearly every other standard of comparison instituted either in anthropology or zoology? Is the long arm of the negro, compared with his length of trunk, according to Baxter and Gould, any the less characteristic because it is a *relation?* How do we measure the peculiarities in posterior extremities of the kangaroo or the rabbit? By their absolute length? It them in each case. In the first of our diagrams it will be noted that we have to do with a very large number of individuals. It illustrates the difference in contour be-

* These we have analyzed with diagrams in *Popular Science Monthly*, LI., 1897, p. 197 *et seq.* A special discussion of the significance of 'type' as distinct from 'race' will appear also in the *Jour. Anth. Inst.*, London, for November, 1898.

tween a curve drawn for a relatively simple population and one in which several distinct types are coexistent. The narrowness and height of the pyramids for the two extremes of Italy culminating at indexes of 79 and 84 respectively, are notable.* The two regions are severally quite homogeneous in respect of the head-form of their population; for the apex of such curves rarely exceeds the limit of fourteen per cent. reached in these instances. The curve for all Italy, on the other hand, is the resultant of compounding such seriations as these for each district of the country. It becomes progressively lower and broader with the inclusion of each differently characterized population. It will be observed, however, that even this curve for a highly complex people preserves vestiges, in its minor apexes, of the constituent types of which it is compounded. Thus its main body culminates at the broadened head-form of the Alpine race; but a lesser apex on the left-hand side coincides with the cephalic index of the Mediterranean racial type, that which entirely dominated in the simple curve for Sicily alone.

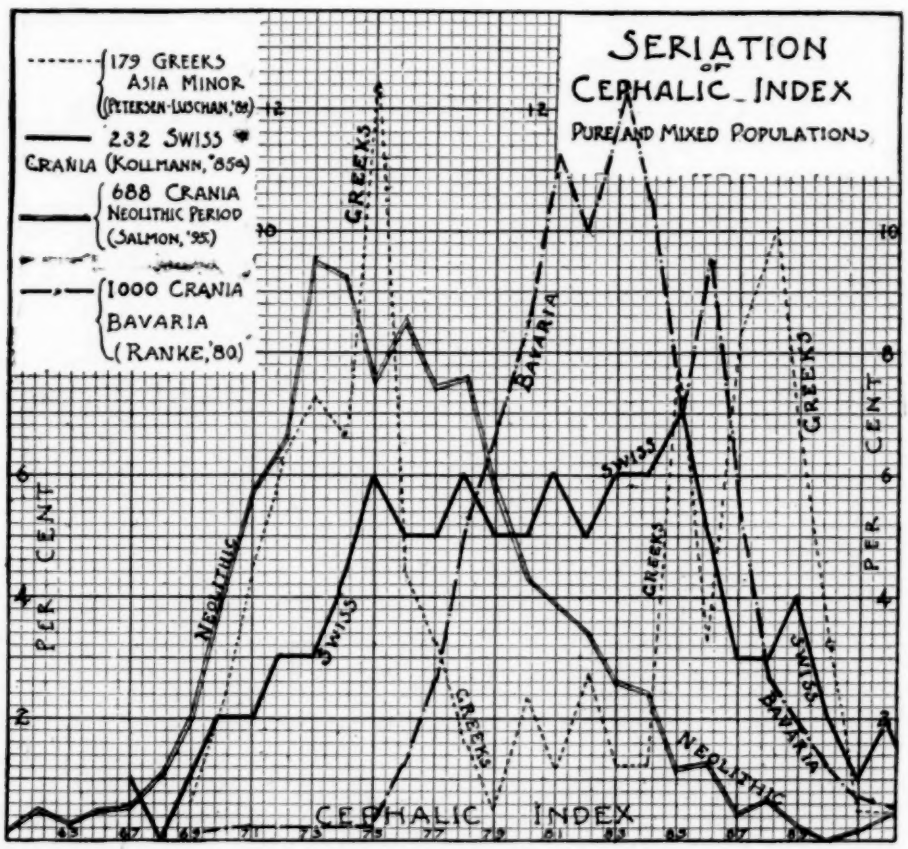

Fig. 2.

Note.—These curves are not strictly comparable with one another in detail; since they are based upon the differing systems of measurement of the French and German schools. Direct comparisons of cranial and cephalic index curves are also impossible. The form in all cases is, however, the same.

The second diagram contains examples of a number of erratic curves. The Swiss one represents a stage of physical heterogeneity far more pronounced than that of all Italy, which we have just analyzed. Or rather, more truly, it is the product of an inter-

* Livi's maps of the distribution of these types in Italy are reproduced in our article on that country, in *Popular Science Monthly*, LI., 1897, p. 721 *et seq.*

mixture upon terms of entire equality of a number of types of head-form. In Italy, as we have seen, the broader head-form so far outweighed the Mediterranean one that a single culminating point of maximum frequency still remained with a lesser one corresponding to the minority partner. In this second diagram Bavaria represents about the same condition as all Italy, with, however, the proportions of the two constituent types reversed. For ; being north of the Alps the culminating apex of greatest frequency lies toward the longer-headed side of the curve. Therein does the dolichocephaly of the Teutonic race make itself manifest.

Compared with these curves for Italy and Bavaria, the Swiss seriation is seen to be devoid of any real apex at all. It represents a population in no wise possessed of distinct individuality so far as cephalic index is concerned. Broad and long heads are about equally common. This corresponds, of course, to the geographical probabilities for two reasons : inasmuch as Switzerland not only lies at the center of the continent; but, also, owing to its rugged surface comprises all extremes of isolation and intermixture within its borders. A stage of heterogeneity absolutely unparalleled seems to be indicated by still another of our curves, that drawn for the Greeks of Asia Minor. It culminates at the most widely separated cephalic indexes, viz., 75 and 88 respectively, known in the human species. The lower index corresponds to the primitive long-headed Greek stock; the other is probably a result of intermixture with Turks, Armenians and others. Or, perhaps, it is nearer the truth to say that the only bond of unity in the entire series is that of language; in other words, that the broad-headed apex represents Turks, Armenians and others, still physically true to their original pattern, yet who have chanced to adopt the speech of the Greeks. Here again is the heterogeneous ethnic composition of eastern Europe fully exemplified by a seriation curve of cephalic index.

In conclusion, we may call attention to the following seriation curve based upon observations taken by Messrs. Fiske and Melluish upon nearly five hundred students

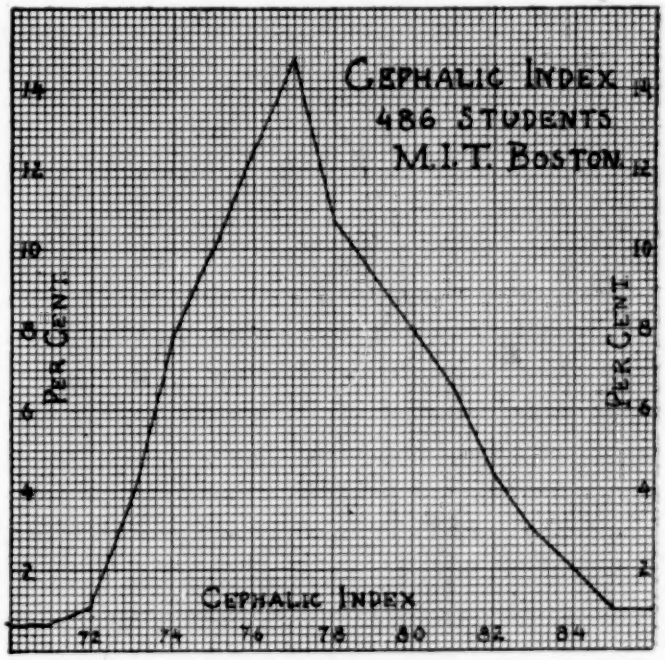

FIG. 3.

at the Massachusetts Institute of Technology. Its simplicity, points to a remarkable homogeneity of physical type, so far as the proportions of the head are concerned. This would seem to be at variance with our notions of the composition of our American population. Yet it should be observed, that this series is one based upon a selected class; selected, in that it comprises those possessed of intellectual ability sufficient to enable them to withstand the pressure of Institute examinations. It appears that this purity of type, culminating at a cephalic index of about seventy-seven, corresponds quite closely to other series taken among peoples of Anglo-Saxon descent, especially in the English universities by Venn and others. From one end of the British Isles* to the other a uniformity in

**Vide* our map in *Popular Science Monthly*, LII.,

this respect is apparent, which leaves little ground for expecting a heterogeneity in America. The broad-headed Alpine race of Central Europe, seems to have been so far excluded from the British Isles as to leave a population quite uniform in its cephalic proportions. A 'type' of head-form certainly transmissible not only from one population to its successor, but over seas as well, seems to be indicated.

William Z. Ripley.
Massachusetts Institute of Technology.

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*THE INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM.**

This was the second occasion the British Association provided the means for a meeting of the scientists engaged in the study and development of our knowledge of terrestrial magnetism, the first magnetic congress having been held at Cambridge as far back as 1845. On the present occasion the Conference was of an international character, thanks to the cordial cooperation between the British Association and the International Meteorological Association, with which latter the Magnetic Conference for the present remains affiliated. It was at the International Meteorological Conference, held at Paris in 1896, that a 'Permanent Committee for Magnetism and Atmospheric Electricity' was appointed; it consisted of eight members with power to add to their number. The British Association allowed the Conference to organize under its President, Professor A. W. Rücker, M.A., D.Sc., as a branch of Section A (Mathematics and Physics), and undertook the expense of sending out the necessary notices to print the papers of the Conference in the report, and with great liberality extended to the foreign delegates of the Conference all the privileges of foreign members of the Association. The Bristol Conference, under its President, Professor A. W. Rücker, was attended by Dr. A. Schuster, of England, and the following foreign members:

Dr. M. Eschenhagen, of Potsdam.
Professor S. Lemström, of Helsingfors.
Professor T. Liznar, of Vienna.
Professor E. Mascart, of Paris.
Ch. Moureaux, of Paris.
Professor L. Palazzo, of Rome.
Gen. M. Rykatchew, of St. Petersburg.
Dr. A. Schmidt, of Gotha.
C. A. Schott, of Washington.

Besides these members various physicists and magnetists were present and took part in the deliberations.

In view of the fact that the United States Coast and Geodetic Survey has been largely engaged in the investigation and study of terrestrial magnetism in this country as forming part of its regular duty, inasmuch as the issue of its maritime charts demands the fullest information procurable, the Superintendent of the Survey proposed sending a delegate to the Bristol International Meeting to take part in the Conference. After approval by the Honorable Secretary of the Treasury instructions were issued by the Superintendent, Dr. H. S. Pritchett, in which he remarks: "The Conference having for its object the advancement of our knowledge in terrestrial magnetism, through communications and intercourse of those interested, you are expected to assist in these deliberations and make such suggestions as seem most appropriate, with a view of increasing our knowledge of the distribution of magnetism over the whole globe and in particular for the region covered by the United States."

The meetings, of which there were ordinarily two a day, one public, the other for consultation and discussion, were held at the University College and in connection

1897, p. 148. Beddoe is best on this subject. Dr. West is the only other American observer studying the school children in Worcester, Mass.

* Held at the Bristol Meeting of the British Association for the Advancement of Science, September 7–14, 1898.

with Section A at the Museum. The Conference was opened with an address by its President giving a short historical review of the present organization, and setting forth as the object of the meeting the need of a closer association for guidance to future well directed and concerted effort in the field of terrestrial magnetism.

Among the questions submitted for deliberation and expressions of opinion were the following: In presenting monthly means of hourly tabulation of differential observations shall simple means only be given or shall they be accompanied by means derived from *undisturbed* values? In this question is involved the difficulty of recognizing a 'disturbed' observation, that is, of fixing a limit separating normal from apparently abnormal values. The discussion respecting the desirability of publishing, besides the usual values for declination, dip and horizontal intensity, at least for the months of January and July, the components of the magnetic force towards the north, the west and the vertical, involved also the the question of uniformity in notation as advocated by Professor F. Bigelow, *i. e.*, whether right or left-handed rotation respecting the axes would be preferable and whether the potential of the magnetic force should be regarded as affected with a positive or a negative sign.

A discussion was had respecting the relative value of long and short magnets. The principal work of the Conference, however, centered in the wider question involving magnetic observatories, their present unsatisfactory distribution over the globe and their inadequacy as regards numbers. It is here that the United States is in a condition to take a most important step in the advancement of knowledge by establishing and maintaining a well equipped magnetic obsevatory either on Oahu or one of the other Hawaiian Islands. This position is unique, being central to a vast unexplored or magnetically unknown region and well adapted for the special study of the modifications which it is supposed the diurnal and secular variations may undergo in consequence of a surrounding ocean as contrasted with a continental surface. The destructive effect of electric tramways or trolley lines, when passing within a fraction of a mile or even within several miles of a magnetic observatory installed with sensitive self-registering instruments, was commented on and pointed out as an evil specially to be provided against in any new magnetic establishment. In considering the selection of positions for new observatories, attention was given to their greater need in the southern than in the northern hemisphere, aiming necessarily at as regular a distribution of all establishments as practicable.

Of special papers brought before the Conference may be mentioned: 'An account of the late Professor John Couch Adams' determination of the Gaussian magnetic constants,' by Professor W. Grylls Adams. 'Sur le mouvement diurne du pole nord d'une barreau magnetique suspendu par le centre de gravité,' par. J. B. Capello. 'On the influence of altitude above the sea on the elements of terrestrial magnetism,' by Dr Van Ryckevorsel and Dr. W. Van Bemmelen. 'On the interpretation of earth current observations,' by Arthur Schuster, F.R.S. 'On magnetic observations in the Azores,' by Albert, Prince of Monaco. 'On a simple method of obtaining the expression of the magnetic potential of the earth in a series of spherical harmonics,' by Arthur Schuster, F.R.S. 'Report of Professor von Bezold and General Rykatchew on the establishment of temporary magnetic observations in certain localities, especially in tropical countries. 'On the relations between the variations in the earth currents, the electric currents from the atmosphere and the

magnetic perturbations, by Selim Lemström. 'On the construction of magnets of constant intensity under changes of temperature,' by J. E. Ashworth. 'Antrag auf Massnahmen zur systematischen Erforschung der Secularvariationen der erdmagnetischen Elemente,' von Dr. Ad. Schmidt in Gotha. 'On magnetic observatories at Funafuti,' by Captain Creak. 'Some remarks on the construction of magnetic observatories,' by Dr. Snellen.

In joint discussion with Section A there was read a report of the committee on comparing and reducing magnetic observations, and in joint discussion with Sections A and G on the magnetic and electrolytic actions of electrical railways. Communications on this subject were made by C. A. Schott, Professor A. W. Rücker, Drs. von Eschenhagen and von Bezold, W. H. Preece, Signor Palazzo and Professor Fleming.

The results of the deliberations of the Conference were embodied in the report to be made to the International Meteorological Conference at its next meeting, and publication may be looked for by that organization and in part in the Proceedings of the Bristol Meeting. It is conceded by those who took an active part in the deliberations that this, the first international magnetic conference, has been most satisfactory in its results, and it is hoped that its fruits will show that the labor spent at Bristol was well directed.

Too much praise cannot be bestowed upon the effective manner in which the sessions of the Conference were presided over, which in no small degree contributed to the success of the meeting, nor will the members ever forget the cordiality of reception and generous hospitality extended to them by their President, the British Association and the Chamber of Commerce of the city of Bristol.

C. A. Schott.

Washington, D. C., October 7, 1898.

THE TENTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, BOSTON, MASS., AUGUST 19 AND 20, 1898.

The Association was convened in the lecture hall of the building of the Society of Natural History, corner of Berkeley and Boylston Streets, and was attended by some 25 active members and a number of entomologists and other zoologists not members of the Association.

The following new active members were elected: Edward M. Ehrhorn, Mountain View, Cal., Horticultural Commissioner of Santa Clara County. W. M. Scott, Atlanta, Ga., State Entomologist. W. F. Fiske, Durham, N. H., Assistant Entomologist. J. L. Phillips, Blacksburg, Va., Assistant Entomologist. H. T. Fernald, Harrisburg, Pa., State Zoologist. E. Dwight Sanderson and Franklin Sherman, Jr., College Station, Md., Assistant Entomologists. A. L. Quaintance, State Entomologist, Florida Experiment Station. E. D. Ball, Assistant Entomologist, Colorado Experiment Station. F. H. Mosher, of the Gipsy Moth Commission.

The following new foreign members were also elected: V. Vermorel, Director of the Station of Viticulture and Vegetable Pathology at Ville France, France. Chas. T. Musson, F.L.S., F.R.H.S., Lecturer on Botany and Vegetable Pathology and Zoology, etc., at Hawkesbury Agricultural College, Richmond, New South Wales.

The reading of papers was preceded by the annual address of President Osborn, on 'The Duty of Economic Entomology.'

The following papers were presented in the order given during the four regular sessions of the Association, Friday and Saturday, August 19th and 20th. The papers in full, with the discussions which they elicited, will be published as a bulletin by the Division of Entomology of the U. S. Department of Agriculture, as has been the custom in former years.

LIST OF PAPERS.

'Two Beneficial Insects introduced from Europe,' L. O. Howard.

'Notes on some of the Insects of the Year in the State of New York,'.....E. P. Felt.

'The Brown-tail Moth (*Euproctis chrysorrhœa*),' C. H. Fernald.

'The Distribution of the San José or Pernicious Scale in New Jersey,'.....J. B. Smith.

'Hydrocyanic Acid Gas as a Remedy for the San José Scale and other Insects,'.....W. G. Johnson.

'Some Notes on Observations in West Virginia,' A. D. Hopkins.

'Notes on House Flies and Mosquitoes,' L. O. Howard.

'*Pulvinaria acericola* (W. and R.) and *P. innumerabilis* Rathv.'.....L. O. Howard.

'An Abnormal Coccinellid,'.....A. F. Burgess.

'Notes on some Massachusetts Coccidæ,' R. A. Cooley.

'Notes on Spruce Bark Beetles,' C. M. Weed and W. F. Fiske.

'A Review of the Work in Economic Entomology in Pennsylvania,'.....H. T. Fernald.

'Experiments with Insecticides for the Gypsy Moth and Brown-tail Moth,'.....A. H. Kirkland.

'Notes on the Life History of the Woolly Aphis of Apple (*Schizoneura lanigera* Haussman),' W. B. Alwood.

'On the Life History of *Protoparce carolina*,' W. B. Alwood.

'Notes on the Fertilization of Muskmelons by Insects,'.....F. W. Rane.

'Notes on Tent Caterpillars,'.....C. M. Weed.

'Recent Work of the Gypsy Moth Committee, E. H. Forbush.

'The San José Scale in Connecticut' (read by title only).....W. E. Britton.

'Insect Injury to Broom Corn' (read by title only), F. H. Chittenden.

'Entomological Ethics' (read by title only), T. D. A. Cockerell.

'Vernacular Names of Insects' (read by title only), E. W. Doran.

'A New Squash Bug' (read by title only), F. H. Chittenden.

'Notes from Maryland on the Principal Injurious Insects of the Year' (read by title only), W. G. Johnson.

'On the Life History of *Thrips tritici*' (read by title only).....A. L. Quaintance.

'Notes on Insecticides' (read by title only), C. L. Marlatt.

'Insects of the Year in Ohio' (read by title only), F. M. Webster and C W. Mally.

An hour was given on Saturday morning to a joint meeting with the Society for the Promotion of Agricultural Science when the papers presented before this Society on entomological subjects were read.

By the courtesy of the Gypsy Moth Commission of the State Board of Agriculture, Massachusetts, an excursion was given to the members of the Association to the districts about Malden where work is being prosecuted against the gypsy moth, opportunity being afforded the members to make an examination of the methods of work followed and the results obtained.

The following officers were elected for the ensuing year: President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette, and Secretary-Treasurer, A. H. Kirkland.

In accordance with the established custom the next session will be held on the two week days preceding the general sessions of the American Association for the Advancement of Science, and at the place selected by the latter body.

C. L. MARLATT,
Secretary.

NOTES ON INORGANIC CHEMISTRY.

IN a paper read before the Chemical Section of the British Association at the Bristol meeting Professor Ramsay describes more fully the isolation and properties of the new element neon. Eighteen liters of argon were liquefied and then fractionally distilled. After three fractionations the lightest fraction had a density of 9.76. This gas no longer liquefies at the temperature of liquid air boiling at 10 mm. and consists chiefly of neon with the admixture of small quantities of argon and nitrogen. Pure neon seems to have a density of 9.6, and, as the ratio between specific heat at constant pressure and constant volume is 1.655, the element is, like helium and argon, monatomic, and its atomic weight therefore 19.2,

following fluorin and preceding sodium in the periodic table. Its refractivity is low, being 0.3071 compared with air, that of helium being 0.1238 and that of argon 0.958. Its spectrum is characterized by brilliant lines in the red, the orange and the yellow, also two lines in the green.

In the last fractions of liquid argon Professor Ramsay finds three new gases, one of them not previously described. These are krypton, which had previously been obtained from liquid air and characterized by two very brilliant lines, one in the yellow and one in the green; metargon, which shows a spectrum closely resembling that of carbon monoxid, but characterized by its inertness, not being changed by sparking with oxygen in the presence of caustic potash; and a still heavier gas, not hitherto described, which Professor Ramsay calls xenon—the stranger. This gas possesses a much higher boiling point than the others and is easily separated, but is present in only minute quantity. Its spectrum is analogous to that of argon, but differs in the position of the lines. The quantity of neon present in the atmosphere is estimated as one part in 40.000, and that of the other gases at even less.

Moissan has described, in the *Comptes Rendus*, a hydrid of calcium of the formula CaH_2, formed by heating crystallized calcium in a stream of dry hydrogen. It is a hard, white crystalline body, stable in dry air, even at a red heat, but burning before the oxy-hydrogen flame. At ordinary temperatures it is not very reactive, but when heated reacts readily with most of the negative elements. It is a powerful reducing agent, decomposing cold water with great violence, with the formation of calcium hydroxide and liberation of hydrogen. In this hydrid the hydrogen thus seems to resemble the carbon in calcium carbid and the phosphorus in calcium phosphid.

How much need there is of a careful revision of much of our knowledge regarding inorganic compounds is well illustrated by two investigations in the last *Berichte*. Muthmann and Nagel, in studying the lower oxidation stage of molybdenum, show that the supposed monoxid MoO has no existence, but is really $Mo(OH)_3$. They also confirm Blomstrand's conjecture that the supposed dichlorid $MoCl_2$ is in reality Mo_3Cl_6. They proved its formula by determining its molecular weight by the boiling-point method.

From the days of Berzelius the dark precipitate formed by alkaline stannous chlorid in a bismuth solution has been considered to be a monoxid of the formula BiO. Vanino and Treubert show conclusively that this precipitate is in reality metallic bismuth with more or less Bi_2O_3, and that BiO cannot be formed in the wet way.

According to *Engineering* aluminum is being introduced into India as a substitute for copper and brass in the manufacture of cooking utensils. Professor Chatterton, of the Madras University, commenced experiments with the metal-working classes of the School of Arts, and a little later a small factory was equipped whose output is now over a ton a month. The vessels have been very favorably received, which is very remarkable considering the conservatism of India. It is necessary, however, that the vessels should be the exact counterparts of the copper and brass vessels previously in use, and they must be hand-made and not spun. Efforts are being made to establish similar factories elsewhere than at Madras.

Three papers by Professor Vèzes have recently appeared in the *Procès Verbaux*, of the Société des Sciences Physiques et Naturelles de Bordeaux, which should be noted. The first is on the double oxalates of platinum and palladium. The platoxalates have been long known, but obtained by a rather

laborious process, which gives rise to beautiful crystals with a coppery red sheen, and which are a very complex oxalate. Under certain circumstances the pale yellow crystals of the normal platoxalate are obtained. Vèzes finds that when the chlorplatinite of potassium is heated with neutral potassium oxalate in a *neutral* solution the platoxalate of potassium is very readily formed with no admixture of more complex compounds. An analogous reaction produces the normal palladoxalates.

A PRACTICAL application of this reaction is made in Vèzes' second paper. With the exception of chlorplatinic acid, potassium chlorplatinite is doubtless the most used platinum compound, being the starting point for all the platinum-ammonium bases. Up to this time no method of its manufacture can be considered satisfactory, especially upon a commercial scale. The reduction of chlorplatinic acid by sulfur dioxid must be very carefully carried out or complex sulfoplatinites result; heating platinic chlorid till two atoms of chlorin are given off is difficult to accomplish with anything like quantitative precision; and the reduction with cuprous chlorid gives a product very difficult to free from all traces of copper. Vèzes suggests the use of oxalic acid in neutral solution. If potassium chlorplatinate (and most platinum residues are of this compound) is boiled with the theoretical quantity—37%—of neutral potassium oxalate in water insufficient to dissolve the platinum salt, in the course of several hours it is quantitatively converted into the chlorplatinite, most of which crystallizes out on cooling and all of which may be recovered by adding alcohol. This operation can be successfully carried out on a large scale. Since the publication of Vèzes' article the method has been tested in the Washington and Lee University laboratory, and I can bear testimony to its success and its great advantage over the earlier methods.

VÈZES' third paper is on the criticism of Dumas on Stas' determination of the atomic mass of nitrogen. Dumas showed the presence of oxygen in silver which has been fused, and calculated that the figure of Stas should be reduced from 14.044 to 14.002, a variation greater than that of experimental error. Vèzes has gone over the calculations, using Stas' original figures and introducing the correction for occluded oxygen, and shows that the original figure of Stas would be reduced from 14.044 only to 14.040, a change far less than the limit of experimental error. Another testimony is thus borne to the wonderfully accurate work of the Belgian chemist.

J. L. H.

BOTANICAL NOTES.

A STUDY OF TOADSTOOLS.

MR. C. G. LLOYD, of Cincinnati, an enthusiastic student of the larger fungi has recently brought out an illustrated paper ('A Compilation of the Volvæ of the United States') which deals with the species of two genera of toadstools, viz.: *Amanita*, with thirty-eight species, and *Volvaria*, with twelve. Nine 'half-tone' reproductions of photographs illustrate the paper. These toadstools are characterized by the young plants being enclosed in a thick membrane, called a volva, and having a soft and fleshy structure, with entire, thin, sharp gills, which do not deliquesce. Some of the species are edible, but so many are poisonous that the author says: "My advice is, Don't eat any Amanitas, and you will make no mistake."

A SOUTHERN FERN FAR FROM HOME.

FOR some time rumors of the occurrence of the Southern Maidenhair Fern (*Adiantum capillus-veneris*) in the Black Hills of southwestern South Dakota have drifted to the Botanical Department of the University of

Nebraska. Their occurrence so far north seemed so unlikely that at first little attention was given to these rumors. At length specimens of this fern were received which were said to have grown wild at Cascade, in the edge of the Black Hills. A personal investigation was the only thing which could settle the matter, for it still seemed very likely that some mistake had been made, and that the specimens received had come from some more southern station. Accordingly I visited the locality August 24, 1898, in company with Dr. F. E. Clements, and we were astonished to find this fern in great abundance along the banks of Cascade Creek. This stream is a couple of metres wide and twenty to thirty centimetres deep, and is fed by several large springs of warm water, having a temperature of about 26° Cent. We very carefully examined the locality and satisfied ourselves that this fern is indigenous and that it has not been introduced by human agency. Since this discovery I have seen specimens of the same species collected at Cascade in 1892, and a fragment collected in 1890 at Hot Springs, ten miles distant, along the banks of Fall Creek, another warm stream. Mrs. Alice M. Crary, a keen observer who has lived many years in the Black Hills, assures me that they grew abundantly along Fall Creek at Hot Springs, 'before that place was settled.'' All this tends to corroborate our conclusion that these ferns were not transplanted by human agency, and that we have here a curious problem in the distribution of a species.

THE FUNCTION OF BLOOM.

As is well known to botanists but not so well known to the general public, the white powdery coating on some leaves and fruits is waxy in nature and is called 'bloom' in technical works on Botany. Its function has received some attention, Mr. Darwin having made it the object of some studies in his later years. In a recent number of the *Laboratory Bulletin*, of Oberlin College, along with papers by the lamented Professor H. L. Jones, is a short one by his assistant, Miss Roberta Reynolds, giving the results of a series of experiments which show that when the bloom is removed from the epidermis the transpiration of water is greatly increased. Thus in case of *Agave utahensis* the loss was about two and a-half times as much from the leaf which was without bloom as from that with the bloom. With *Echeveria peacockii* it was two and a-third times as much; with *Agave verschaffelti* one and four-tenths; *Agave americana* about two and a-half; an undetermined *Agave*, two times as much; two unnamed species of *Cotyledon*, about one and one-third. It was observed, also, that on damp days the difference between the leaves was less than on dry days; so, too, there was less difference in the case of young leaves than when old ones were used.

A TINY PINE TREE.

Last summer I climbed Green Mountain, near Boulder, Colorado, and found growing from a crevice in one of the rocks at the summit a small tree of *Pinus albicaulis* Engelm., about thirteen centimeters high and five millimeters in diameter. It was unbranched, and bore a single, terminal tuft of leaves. And yet this tiny tree, when carefully examined, was found to have twenty-five distinct annual rings. I know of no other case of natural dwarfing carried to such an extreme, and, therefore, place this one on record.

Charles E. Bessey.
The University of Nebraska.

CURRENT NOTES ON ANTHROPOLOGY.

BOTANICAL KNOWLEDGE OF THE ANCIENT AZTECS.

Students of ancient Mexico are acquainted with the work of Dr. Hernandez, who was sent by Philip II. to study the plants and

minerals of New Spain. His 'Natural History' was printed in 1651 and is a storehouse of the knowledge of the Aztecs on that subject. In describing a plant he always gave its native name and how employed by the Indians.

In the *Anales del Instituto Medico Nacional*, Tom. II., No. VI., 1898, is an article by Dr. F. Altamirano, in which he endeavors to identify the plants mentioned by Hernandez and give their modern botanical names. He quotes fifty-one, assigning most of them to genera and species, and adds the modern uses to which they are applied. The article forms a useful appendix to Hernandez.

SEXUAL DIMORPHISM IN MAN.

In a pamphlet of about forty pages Prof. Dr. Giuseppe Marina sums up the results of his measurements of 22,755 adults, Italians, Slavs and Germans. His studies tend to diminish the value of the skull-form as a criterion and to cast doubt on the 'criminal type.' But the most novel of his results relate to the relation of the sexual characteristics in general to the pelvic diameters. He formulates the law that in proportion as the pelvic index in the one sex approaches that of the other, this similarity will be correlated to a cranial form and capacity, and to a number of traits, physical and mental, which belong to the other sex. Feminilism in the male, for example, is displayed by the length of the iliac crests, the shortness of the inferior extremities, a wider pubic angle, ampler cotyloid cavities, greater distance of the umbilicus from the pubis, development of the mammæ, etc. Dr. Marina points out that these traits are racial, sexual dimorphism being much more marked in some than in other stocks. The point is of wide-reaching significance. (*Studii Antropologici sugli Adulti.* Torino, 1897. Fratelli Bocca.)

HEREDITY; A CONTRAST.

In the *Revue Scientifique* for April last Dr. Cesare Lombroso, in an able discussion of the relative influence of heredity and environment, announced the conclusion that "the influence of environment is potent enough to annihilate all ethnic traits."

At the meeting of the German Anthropological Society in August of this year Professor Kollmann, of Basel, in an address on the same subject, stated the dictum of science to be that "the influence of heredity is far stronger than that of environment. The ethnic traits are immortal and persist, though the peoples who bear them may disappear from history." (*Globus*, Aug. 27, 1898.)

These are two of the most eminent authorities among European anthropologists. As the traditional circus man said: "You pays your money and you takes your choice."

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

THE CONFERENCE ON AN INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

THE Second Conference on an International Catalogue of Scientific Literature began its sessions in the rooms of the Royal Society on October 12th. On the preceding evening the President and Council of the Society gave an 'At Home' to meet the delegates, and a dinner followed on the evening of the 12th. The foreign delegates in attendance at the opening of the Conference were: France, Professor Darboux and M. Deniker; Austria, Professor Weiss and Professor Boltzmann; Hungary, Dr. A. Heller and Dr. Theodore Duka; Holland, Professor Korteweg; Belgium, M. Descamps, M. Otlet and M. Lafontaine; Switzerland, Dr. J. Henri Graf and Dr. Jean Bernoulli; Japan, Professor Einosuke Yamaguchi; Norway, Dr. J. Brunchorst; Sweden, Dr. E. W. Dahlgren; United States, Dr. Cyrus Adler. Men of science throughout the world are greatly interested in

the plan of an international catalogue of scientific literature, and it is to be hoped that an opportunity will be given for full discussion and careful consideration before the final arrangements are made. We regret to state that no such opportunity has been hitherto offered. SCIENCE, as other scientific journals, was unable to secure satisfactory information regarding the first Conference at the time, though we were fortunate in being able to publish (Vol. VI., pp. 184–201) a year later an admirable account of the Proceedings, based upon official documents, by Dr. Cyrus Adler, the delegate from the United States to the present Conference. No similar accounts, so far as we are aware, have been given in other scientific journals, nor is this surprising, as the Proceedings of the last Conference were not distributed, only two copies, it is said, having been sent to America. Scarcely any mention has been made of the schedules of classification which have recently been drawn up, and which will doubtless be discussed by the present Conference. These schedules have apparently not been sent to scientific journals nor to men of science. The schedule on anthropology has, however, been severely criticised by Dr. Brinton (SCIENCE, p. 375). At the last Conference a decimal system of classification was practically rejected, but it appears that the Committee on Organization have adopted a new system of decimal classification, and it is by no means certain that this system is better than Dewey's. We find in the English press full accounts of the reception and dinner, but as yet nothing regarding the scientific proceedings of the Conference.

GENERAL.

PROFESSOR BOWDITCH, President of the American Society of Naturalists, called a meeting in Boston and gave a dinner to the Executive Committee on the 22d ult. Professor Dean was appointed a delegate to represent the New York Local Committee. The American Society of Naturalists and affiliated societies will, it will be remembered, meet in New York during the last week of the present year. We hope to be able to give full announcements regarding the meetings at an early date.

THE class of 1893 of Williams College has established a prize of $25 in memory of the late Franklin Story Conant, who, it will be remembered, sacrificed his life to scientific work in Jamaica. The money is to be used for a scholarship at the Woods Holl Marine Biological Laboratory.

THE Civil Service Commission announces that on December 6, 1898, the examination may be taken at any city in the United States where the Commission has a board of examiners, for the position of Chief of the Bureau of Statistics, Treasury Department, at a salary of $3,000 per annum. The examination will consist of the subjects mentioned below, which will be weighted as follows:

Science of Statistics—	
(*a*) Topical,	10
(*b*) Textual,	5
Mathematics,	5
Literature of statistics,	10
Practical statisticism—	
(*a*) Tabulating,	5
(*b*) Analysis and graphics,	5
(*c*) Commercial statistics,	10
General and technical education,	20
Administration—	
(*a*) Positions held and experience,	15
(*b*) Essay,	15
Total,	100

THE Commission also invites attention to the fact that no applications were filed for the examination scheduled to be held in New York September 21, 1898, for Assistant Engineer, first-class, in the custodian service in that city, at a salary of $1,080 per annum, and that another examination is scheduled to be held on November 15, 1898.

WE learn from *Nature* that, by a decree dated August 30th last, the Belgian government has separated the astronomical from the meteorological service, each of these departments being placed under a responsible scientific director; while administrative duties, care of instruments, library, etc., are to be under the control of an inspector. The astronomical service is placed under M. C. Lagrange, and meteorology under M. A. Lancaster, each of whom will submit a report quarterly to the Minister of the Interior upon the work of his department.

THE Thompson-Yates Laboratory of the Liverpool University College was formally opened by Lord Lister on October 8th. We have already described the laboratories of pathology and physiology presented to Liverpool University College by Mr. Thompson-Yates, which, under Professors Boyce and Sherrington, are certain to make important contributions to science. Before the opening of the laboratories, Lord Lister was invested with the honorary doctorate of science of the Victoria University, and made an address. There was further a banquet given by the Lord Mayor, at which speeches were made by the Lord Mayor, Lord Lister, Earl Spencer, Mr. Edward Lawrence, Sir William Turner, Professor Foster, Principal Glazebrook, Professor Sherrington and Professor Virchow.

IT is proposed to erect a suitable memorial to James Clerk Maxwell, in the parish church of Corsock, of which he was a trustee and elder. Subscriptions may be sent to the Rev. George Sturrock, The Manse, Corsock by Dalbeattie, N. B.

A MONUMENT to the memory of Sigismondo Boldoni, physician, poet and philosopher, has been erected in Milan, where he was born in 1597.

THERE will shortly be dedicated a monument to the physiologist Ernst von Fleischlmarxow. It consists of a bust in profile by Emil Fuchs and will be unveiled with appropriate ceremonies.

BUSTS of General Champion de Nansouty and of M. Vaussenat, the engineer, founders of the National Meteorological Observatory on the Pic du Midi, have been recently unveiled. Addresses were made by M. Mascart and M. Baillaud, Directors of the Toulouse Observatory.

IT is announced that Sir Andrew Noble will give to the Kew Observatory the installation needed to make direct comparisons with the gas thermometer. This has been hitherto lacking, although Kew is the British station for standardizing thermometers. The entire endowment of the Kew Observatory, it appears, is only £470 and the free use of a building. It is to be hoped that the government will follow the advice of their Committee on a National Physical Laboratory, and provide the adequate endowment for a laboratory at Kew.

THE vacancy in the Assistant Directorship of Kew Gardens, says *Nature*, caused by the appointment of Mr. D. Morris as Commissioner of Agriculture for the West Indies, will not be filled. Mr. S. T. Dunn has been appointed Secretary to the Director. Upon the nomination of the Director, Mr. C. A. Barber has been appointed Government Botanist at Madras, in succession to the late Mr. M. A. Lawson.

MR. C. S. PARSONS has been appointed Director and Irrigation Engineer of the Arizona Agricultural Experiment Station.

THE British Astronomer Royal (Mr. W. H. M. Christie, C.B.) has been elected junior warden of the Clockmakers' Company, which received its charter in 1631 from King Charles I. The late Astronomer Royal (Sir George B. Airey) was also closely associated with the Clockmakers' Company.

WE regret to record the death of Professor Arzruni, mineralogist, in the Polytechnic Institute at Aix, and of the geologist de Windt, while on a scientific expedition to Lake Tanganyika.

THE 'Harben Lectures' in connection with the Institute of Public Health, London, will be delivered by Sir Richard Thorne Thorne, on November 2d, 9th and 16th. The subject will be 'The Administrative Control of Tuberculosis.'

SIR DOUGLAS GALTON, K.C.B., will give, on October 17th, an address introductory to the twenty-sixth course of lectures and practical demonstrations in sanitary science arranged by the Sanitary Institute of Great Britain for sanitary officers and students at the Parkes Museum.

THE third annual meeting of the New York State Science Teachers' Association will be held at the Teachers College, Columbia University, New York City, on December 29th and 30th. The President of the Association is this year Professor Charles W. Hargitt, of Syracuse University; the Secretary is Dr. Franklin W. Barrows, of the Buffalo High School (45 Park St., Buffalo, N. Y.), from whom information regard-

ing the important work of the Association may be obtained.

We learn from *Nature* that the banquet of the Chemical Society to those of its past-Presidents who have completed fifty years' fellowship of the Society, which was postponed last June owing to the lamented death of the senior past-President, Lord Playfair, is now arranged to take place on Friday, November 11th, at the Hôtel Métropole. The past-Presidents who will then be entertained are: Sir J. H. Gilbert, F.R.S.; Sir Edward Frankland, F.R.S.; Professor Odling, F.R.S.; Sir F. A. Abel, Bart., F.R.S.; Dr. A. W. Williamson, F.R.S., and Dr. J. H. Gladstone, F.R.S.

Foreign scientific journals state that Professor P. Knuth, of Kiel, is starting this month on a scientific expedition round the world, extending over from eight to ten months. He proposes a considerable stay in Buitenzorg, Java, visiting India on his way, and afterwards China and Japan, Honolulu and North America. Professor K. Goebel, of Munich, is also starting, this autumn, on a botanical journey to Australia and New Zealand.

Mr. N. R. Harrington gave a lecture, on October 24th, at Columbia University on the Senff Zoological Expedition, reported in the last issue of this Journal.

The University of Pennsylvania and the Academy of National Sciences have received valuable collections of specimens from Alaska, secured near Point Barrow, as the result of a scientific expedition under the management of E. A. McIlhenny, of Lousiana, fitted out and conducted by N. G. Buxton, of Ohio, and W. E. Snyder, of Wisconsin. The Boston *Transcript* states that there are nearly 13,000 specimens in all. The zoological, botanical and ornithological specimens, which constitute the largest part of the collection, have been disposed of to the Academy of Natural Sciences, while the ethnological and anthropological portion will enrich the already large collection in the Museum of Archæology and Paleontology at the University of Pennsylvania.

The city of Bombay has provided for the establishment of a laboratory under the Directorship of Dr. Galeotti, professor of pathology in Florence, for the preparation of Professor Lustig's curative serum for the plague.

The California State Board of Health has appointed Dr. C. A. Ruggles, President of the Board, to visit the Hawaiian Islands, to learn the extent of the presence of leprosy and report measures to prevent its introduction into California. Since the annexation of Hawaii its inhabitants are free to come to the United States, and it is the intention of the Board of Health to prepare a report for submission to the Legislature which will suggest safeguards against the spread of leprosy in California.

The following figures regarding the relative cost of the military and educational establishments of four leading nations deserve careful consideration at the present time:

	Army and Navy.	Education.
Great Britain	£40,650,000	£10,140,000
Germany	32,840,000	12,120,000
France	36,570,000	7,920,000
United States	16,700,000	36,890,000

In round numbers France spends seven times as much in preparation for war as in preparation for peace, Great Britain four times as much and Germany two and a-half times as much, whereas America has hitherto spent more than twice as much for education as for armaments. If the military expenditures of the United States must be increased, let the expenditures for education be increased in at least the same ratio.

Dr. Hermann Nothnagel, professor of pathology in the University of Vienna, has been carrying out in his laboratory experiments on the bacillus of the bubonic plague, which have resulted disastrously. The assistant in the laboratory, Dr. Barisch, contracted the plague and died. The physician, Dr. Müller, and the two nurses who attended him have also contracted the disease and Dr. Müller has died. The lectures at the pathological institute have been suspended, and all Dr. Nothnagel's assistants and attendants have been isolated. The government has appointed a committee, containing representatives of national and municipal bodies, to devise measures to prevent the spread of the plague.

Irving W. Fay, professor of chemistry in the Brooklyn Polytechnic Institute, while show-

ing an experiment to his class, it is said, with liquid air and red phosphorus, met with an accident, through a violent explosion, which may cause the loss of his eyesight. One of the students was also injured.

AN inquest has been held in London in regard to the cause of the death of Harold Frederick, the well-known novelist and newspaper writer, owing to the fact that he was attended in his illness by a 'Christian Scientist.' The physicians who had been dismissed testified that he had suffered from rheumatic fever and paralysis and declared their belief that he would have recovered with proper treatment. According to English law the 'Christian Scientist' may be prosecuted for manslaughter.

THE report of the principal chemist upon the work of the Inland Revenue Branch of the Government Laboratory of Great Britain for the year ended March 31, 1898, shows that the number of analyses and examinations made during the year amounted to 65,313, this being a slight increase over the previous year.

THE Navy Department is issuing to volunteers who passed examination for admission to the United States Navy during the late war with Spain, but who are not given commissions because of the early termination of the war, certificates stating the facts and the reason for their non-acceptance. The document, which is nicely got up, will be a helpful certificate for many of its recipients and a pleasant souvenir for all.

THE Museums and Lecture-rooms Syndicate, of Cambridge University, in their annual report for the past academical year, says the London *Times*, alludes to the loss the Science Schools sustained by the death of Professor Roy, the first professor of pathology. To his energy is due the establishment of one of the most successful of the departments connected with medical studies. He possessed the power of attracting workers to Cambridge, and many of his pupils now hold important posts, not only in Great Britain and the colonies, but also in the United States of America. The reports of the Woodwardian professor of geology, of the professor of botany, and of the Superintendent of the Museum of Zoology, draw attention to the overcrowded state of their respective departments and the need, which is becoming increasingly urgent, for new and more spacious accommodation both for the students and the collections under their charge. The recently erected buildings for the department of mechanism have proved insufficient for the growth of the school, and the need for another lecture-room and more laboratory space has become pressing. The buildings devoted to medicine and surgery are not only in a bad state of repair, but are also inadequate and inconvenient. During the past year very considerable additions to the collections have been made. Numerous expeditions which have left Cambridge to prosecute researches in far-distant lands have returned, and the collections they have brought home are both valuable and extensive. Especial mention may be made of a series of lepidosiren and its embryos and a valuable collection of other specimens from South America, which have been presented to the Museum of Zoology by J. Graham Ker, B.A., Christ's College, and J. S. Budgett, Trinity College; of the large collections illustrating the fauna of the South Pacific coral reefs collected by J. Stanley Gardiner, M.A., Gonville and Caius College, during his recent visit in the coral-boring expedition to Funafuti, and presented by him to the same museum; and of the varied and valuable collections made by Dr. Willey (Balfour student) in New Britain and the neighboring islands. The collection of crania which Dr. Willey has presented to the Museum of Human Anatomy is mentioned by the professor, who also draws attention to the valuable donation of Egyptian skulls made by Professor Flinders Petrie. Part of the collections made by Dr. Haddon in Torres Straits in 1888–89 has been presented to the Museum of Zoology, which has been further enriched by a skeleton of the elephant seal presented by Sir W. L. Buller, K.C.M.G., and many other donations mentioned in the report of the Superintendent. The Rev. Professor Wiltshire has presented a very valuable and extensive collection of minerals to the Mineralogical Museum, and H. H. W. Pearson, B.A., Christ's College, has added to the Botanical Museum a collection of plants which he made during his recent journey to Ceylon.

UNIVERSITY AND EDUCATIONAL NEWS.

In his opening lecture to the engineering students at Cambridge, on October 14th, Professor Ewing intimated that the crowded state of their lecture rooms and laboratories would soon be relieved. A gift of £5,000 had just been made for the addition of a new wing to the engineering laboratory in memory of the late Dr. John Hopkinson and of his son, John Gustave Hopkinson, who recently lost their lives in the Alps. Dr. Hopkinson's son was to have begun work at this time as a student of engineering at Cambridge. This gift was made by Mrs. Hopkinson jointly with her son Bertram and her surviving daughter.

The litigation commenced by the heirs of the late Dr. Elizabeth Bates, who left a bequest of $160,000 to the Michigan University, seems in a fair way to end in favor of that institution. It is reported that the contestants of the will have concluded to relinquish all claim to the personal property of the decedent, amounting to $120,000, and the Court has ordered this amount to be turned over to the University authorities. This leaves only the remainder of the bequest, $40,000, which is the subject of litigation.

Miss Wheeler has presented $5,000 to the permanent library fund of Williams College, as a memorial to her father, who was a graduate of the College.

Commemoration Day at Princeton University, which has been established since the sesquicentennial two years ago, was celebrated on October 22d, the chief event being an address by President D. C. Gilman, of Johns Hopkins University.

It is understood that Professor G. J. Brush, Director of the Sheffield Scientific School, will retire next January, after service as executive head of the School since 1872.

Dr. B. Moore, formerly instructor in physiology in University College Hospital, has been appointed professor of physiology in the Yale Medical School.

Dr. Albert Mathews has been appointed assistant professor of physiology at Tufts College.

Lucien N. Sullivan, of the Sheffield Scientific School, and John C. Peck, of the Rose Polytechnic Institute, have been appointed instructors in mechanical engineering in Lehigh University.

The chair of botany at Oberlin College, vacant by the death of Professor Herbert Jones, has been filled by the appointment of Frederick O. Grover. Mr. Grover was graduated from Dartmouth in 1890, and subsequently continued his studies at Harvard University.

The faculty of the University of Vienna, says *The Philadelphia Medical Journal*, has nominated the following, in the order named, one of whom shall succeed the late Professor Stricker, professor of experimental pathology: Professor von Mering, of Halle; Professor Knoll, of Prague; Professor Klemensiewicz, of Gratz; Professor Lowit, of Innsbruck.

Professor Bartholomew Price, Master of Pembroke College, has resigned the Sedleian chair of natural philosophy at Oxford University on the completion of his eightieth year. Oxford University has suffered a more serious loss in the resignation of Professor Ray Lankester to accept the Directorship of the Natural History Museum. Oxford is not so strong in science that it can afford any loss, and it is to be hoped that chairs in physics and comparative anatomy may be filled by men of science who will exert an important influence in the much needed development of the University.

DISCUSSION AND CORRESPONDENCE.

A RULE FOR FINDING THE DAY OF THE WEEK CORRESPONDING TO A GIVEN DATE.*

'Perpetual' calendars that can be consulted with greater or less readiness are to be found in works on astronomy and in encyclopædias, but I have not found any published rule for the simple problem of determining mentally the day of the week without reference to a calendar or lengthy table. Therefore, I venture to submit the rule that I have devised for this purpose.

* Read at the Fifth Summer Meeting of the American Mathematical Society.

To find the day of the week corresponding to a given date, add to the day of the month the index number of the month and the index number of the year, then subtract the largest multiple of seven that is less than the sum. The remainder will be the number of the day of the week.

The index numbers of the months are as follows:

January, 3 (in leap years, 2).
February, 6 (in leap years, 5).
March, 6.
April, 2.
May, 4.
June, 0.
July, 2.
August, 5.
September, 1.
October, 3.
November, 6.
December, 1.

To find the index number of the year, for any year from 1800 to 1899 inclusive, increase the excess of the year over 1800 by one-fourth of itself (discarding fractions) and subtract the largest multiple of seven contained in the sum. For dates in other centuries a multiple of 28 is added or subtracted so as to bring the year within the above limits, and, after finding the index number for the resulting year, one is likewise added or subtracted for each centesimal year not divisible by 400 that is passed over (or of which the beginning is passed over). If many years are to be passed over it is often convenient to use multiples of 112.

A few illustrations of the application of this rule are here given. To find the day of the week corresponding to August 20, 1898, we add the index numbers of the year, 3, and of the month, 5, to 20, and subtract 3 times 7. The remainder, 7, indicates that this is the seventh day of the week, or Saturday. If the index numbers of all the months and of a given year are known, it is ordinarily quicker to find the day of the week mentally than to consult a calendar of the given year. For July 4, 1776, we add 28 to 1776 and find the index number of 1804 to be 5; adding one for the year 1800 passed over gives 6, the index number of 1776; to which we add $2 + 4$; subtracting 7 we have the remainder 5, indicating Thursday. For December 25, 2046, we deduct 224 from the year and find the index number of 1822 to be 6. Deducting one for the year 1900 passed over (2000 is divisible by 400 and so is a leap year and requires no deduction), we find 5 as the index number of the year 2046. Adding $1 + 25$ we find that Christmas of that year will come on Tuesday.

As this subject is so simple it would be unnecessary to give a deduction of the rule. But it may be noted that if the index numbers of the months are not remembered, that of one month may be found by adding the index number of the year to the day of the month (for any date for which the day of the week is known) and subtracting the sum from the day of the week increased by a multiple of seven. The index numbers of the remaining months may then be obtained in succession, as the index number of any month, except January, is equal to that of the preceding month increased by the number of days therein and diminished by a multiple of 7.

Dates given in old, or Julian, style should first be changed to new, or Gregorian, style. The Dominical letter of any year may be found by deducting the index number of the year from 5 or 12. Thus for 1898 we have $5 - 3 = 2$, indicating the second letter of the alphabet, or B, as the Dominical letter.

If in time it should be more convenient to calculate the index numbers of the years from the excess of the years over 1900 instead of 1800, that modification of the rule may be made if the index numbers of the months are increased by 5 or diminished by 2.

EDWARD L. STABLER.

BROOKLYN, N. Y.

AN APPLE CANKER.*

LAST spring I began investigating the cause of the so-called apple canker. This disease attacks the bark of the larger limbs, where all stages of development may be seen from small sunken areas to the large cankers of many inches extent. In aggravated cases a portion of the wood is laid bare. The bark becomes swollen and rough in all directions from the

* M. B. Waite, *Rural New Yorker*, February 5, 1898, p. 82.

wound, so that the diseased limbs become quite conspicuous. These wounds produce an effect similar to girdling, and where many limbs are attacked the effect on a tree is disastrous.

In preliminary work on the disease certain large dark-colored spores were continually found, but they were supposed to come from some saprophyte not worthy of attention. In cultures made from diseased bark this form, together with another, continually appeared. Finally both forms were separated and transferred to bean stems in test tubes. In the one case the familiar dark spores were produced, while in the other the sporophores of *Schizophyllum commune* were formed.

Inoculations were made with both forms on apple seedlings in the nursery and on limbs of an apple tree. In two weeks' time it was found that in every case inoculations made from the fungus with dark spores had taken effect, while the *Schizophyllum* had in no instance made any growth. The wounds made in the bark of check trees healed over at once. More inoculations were now made and the results have been the same. At this date, October 9th, several of the seedlings are nearly girdled with wounds three to four inches in length. The inoculations on the limbs of apple trees have made an equally satisfactory growth, laying bare the wood and producing the dead, sunken areas of bark characteristic of the disease.

When it was found that the fungus with the dark spores was parasitic, diligent search was made for the spores on diseased bark, but none were to be found. This was in the fore part of July. Further search throughout the summer failed to reveal any of the spores.

On September 11th Mr. F. C. Stewart, Botanist of this Station, examined the test-tube cultures and at once noted the strong resemblance of the dark spores to those of the black rot of the apple, *Sphæropsis malorum*, Peck. Mature apples were at once inoculated with material from the test tubes. In twenty-four hours decay had begun around points of inoculation, and in 16 days pycindia and mature spores of *Sphæropsis* were found on all inoculated apples. The check apples which were punctured but not inoculated remained sound. Further search for the dark spores on diseased bark revealed pycnidia just beneath the epidermis containing the mature brown spores and immature ones still attached. All characters were identical with *Sphæropsis* on the fruit. These same pycnidia were subsequently found on bark of the nursery stock and apple-tree limbs where the inoculations were made. Pure cultures of *Sphæropsis malorum* from apples make the same growth on bean stems and bear fruit in exactly the same manner as the first cultures from which the inoculations were made.

While it seems reasonably certain that this canker of the apple is caused by a well-known fungus in a hitherto unrecognized rôle, the result of a set of experiments now under way is awaited to complete the chain of evidence. Seedlings placed in the greenhouse have been inoculated with pure cultures of *Sphæropsis malorum* taken from affected apples. If these inoculations produce the so-called canker the identity of the disease will be established.

W. Paddock.

WAMPUM BELTS.

To the Editor of Science: Thanks for the kind notice of my article on wampum by my esteemed friend, Dr. Brinton. I wish, however, to correct the word 'acknowledges,' as it seems to imply that I believe in the early use of council wampum, a belief against which I have argued for years. In a very mild way I stated that 'it is very doubtful whether wampum belts were used before the coming of the whites as necessary or ordinary parts of Indian councils.' I thought quill belts might have been used, as in the Onondaga tradition of Hiawatha. Because of the great rarity of shell beads on early sites in New York and Canada, I thought 'a mistake has been made regarding Cartier's account of Hochelagan beads in 1535.' But one shell bead has been found at Hochelaga, and there is a corresponding rarity on early Mohawk and Onondaga sites. Quoting another I said, "My own experience is the same, Prehistoric Onondaga sites yield few shell articles or none at all."

I have examined as many wampum belts and as much council wampum as most men, and my conclusion is precisely that of Dr. Brinton.

"All known to me are later than the discovery, and none have been found in ancient burials." He is fully sustained by facts in his historic doubt 'that wampum belts were made by the prehistoric Indians.' When the New York bulletins on archæology reach the use of shell articles, I hope, should I prepare that paper, to show this in detail. The material is in hand, but not yet arranged. Meanwhile it is certain that the early interior inhabitants of New York knew little of shell beads at all.

W. M. BEAUCHAMP.

SCIENTIFIC LITERATURE.

Practical Plant Physiology; an Introduction to Original Research for Students and Teachers of Natural Science, Medicine, Agriculture and Forestry. By DR. W. DETMER, Professor of Botany in the University of Jena. Translated from the second German edition by S. A. MOOR, M. A. (Camb.), F. L. S., Principal of the Girasia College, Gondal, Kathiawad, India. With one hundred and eighty-four illustrations. New York, The Macmillan Co.; London, Swan, Sonnenschein & Co. 1898. 8vo. Pp. xix + 555. Price, $3.00.

The laboratory method of study finds variable application in the several departments of botany, but in none is it so typically and profitably serviceable as in the domain of physiology. The strong chemical and physical bias which pervades the subject permits almost every vital operation of the plant to be brought under control by chemical or physical methods. As changes and movements in plants are usually slow, the greatest delicacy of method and apparatus is often required to secure intelligible results. In consequence of these facts the laboratory part of instruction in vegetable physiology is destined to become varied and extensive, and to take form slowly.

It is to the credit of Dr. Detmer, of Jena, that he presented to the botanical public the first manual in any language for the guidance of the student in vegetable physiology. It was a work of over 350 pages, issued in 1888, and although at the time it was said by some of his colleagues not adequately to represent the current state of the science, yet time has shown that for an initial work it was exceptionally well achieved, and that to produce a more representative and serviceable volume has been a task that few have since attempted. After a decade the work has passed into a second edition, so much changed and amplified as to almost constitute it a new book, but retaining the characteristics that have made its predecessor so acceptable to many instructors and students.

Although a French edition appeared in 1890, no English version has been prepared until the present time. That it has now been made available to the English-speaking student will be welcome information to many instructors who have heretofore made less use of the work than desired. It is gratifying to find that the translation has been well done, and that it adequately expresses not only the facts of the volume, but the sense of the author's personal interest, which lends a charm to both German and English versions. An unusual feature of the translation is the rendering of the whole volume without addition or alteration. This is, in some respects, a good method, as one receives from the hands of the translator the unsophisticated result of the author's labor, but when it extends to the translation of an appendix giving the places in Germany where apparatus may be obtained, it seems as if the substitution of names of firms in the countries where the book is expected to be used would have been a meritorious deviation.

The outline of the work embraces the food of plants, the molecular forces in plants, metabolic processes, movements of growth and movements of irritation. It contains but little matter not truly a part of physiology, according to strict interpretation of the term. The two hundred experiments, or, more properly speaking, studies, into which the work is divided, cover a great variety of topics and are drawn largely from the memoirs of the most distinguished investigators. But it is to the labors of the author in testing, modifying and adapting the experiments to the condition of pedagogical requirement that give them much of their value in this connection.

It would be easy to find fault with some parts of the work. The first experiments given in the book, those of water cultures, are likely to prove discouraging to the beginner, as they re-

quire much attention, extend over a long period, and are often failures owing to conditions that require experience to foresee and control. Some f the experiments require technical knowledge nd skill not to be expected of the average pupil who presents himself for this class of work, as, for example, where the directions say to determine the nitrogen by Kjeldahl's method or by Stutzer's method, and with a reference to a chemical treatise proceeds to the next step in the experiment as if the quantitative determination of nitrogen were an everyday affair in a botanical laboratory.

But these defects, or limitations, may be dismissed as not impairing the usefulness of the work, if it be understood at the outset that the book is not adapted to seriatim study by the classes of any institution, unless it be those of the author, at least not those in any American institution. But a sufficient wealth of material is provided so that the instructor may select what best suits his purpose, and under this eclectic system the work must commend itself as highly satisfactory and serviceable.

J. C. Arthur.

Quantitative Chemical Analysis by Electrolysis. By Dr. Alexander Classen, Privy-Councillor, Professor of electro-chemistry and inorganic chemistry in the Royal School of Technology at Aachen; in cooperation with Dr. Walter Löb, lecturer on electro-chemistry in the Royal School of Technology at Aachen. Authorized translation, third English from the revised and greatly enlarged fourth German edition, by William Hale Herrick, A.M., formerly professor of chemistry in Iowa College and in the Pennsylvania State College, and Bertram B. Boltwood, Ph.D., instructor in analytical chemistry in the Sheffield Scientific School of Yale University. New York, John Wiley & Sons; London, Chapman & Hall. 1898. Pp. 301.

The earlier editions of Classen's book are so well known that it is only necessary to call attention to the difference between this and preceding editions. The book is greatly improved by the introductory chapter on the theory of electro-chemistry. Says the author in his preface: "The present edition, revised with the assistance of Dr. Löb, differs from the previous editions in that the introduction has been augmented by the insertion of a section devoted to theory. This was made the more necessary since the investigations of recent years have been chiefly devoted to the explanation of reactions in solutions and the determination of electrical magnitudes." This chapter deals with the theory of electrolytic dissociation, the laws of Faraday and Ohm, the significance of tension, current strength, and resistance, the theory of electrolytic precipitation.

The remainder of the 'general part' of the book takes up the methods of measuring the strength of the current, the measurement of current tension, the sources of current, including primary and secondary batteries, and physical means of producing the current, such as electro-magnetic machines and thermopiles. Given the means of producing, regulating and measuring the current, it remains to apply the methods to the precipitation and separation of the metals. These are described in the 'special part' of the book, and it is safe to say that most of the best electro-chemical methods are included here. The appendix contains a number of practical examples of electro-chemical analysis.

This book comes from one of the leading authorities, and is generally recognized as a standard in the field which it covers.

H. C. J.

Introduction to Electro-chemical Experiments. By Dr. Felix Oettel. Translated by Edgar F. Smith. Philadelphia, P. Blakiston, Son & Co. 1897. Pp. 143.

Practical Exercises in Electro-chemistry. By Dr. Felix Oettel. Translated by Edgar F. Smith. Philadelphia, P. Blakiston, Son & Co. 1897. Pp. 92.

The first of these two little books by Oettel deals with the conditions necessary for electro-chemical experiments, such as sources of the current, methods of measuring the current, including different forms of the voltameter and galvanometer, and methods of measuring pressure. The arrangement of apparatus and electrolyte in carrying out an experiment is then taken up. This is followed by a brief discus-

sion of polarization currents, Faraday's law, ion transference, preliminary experiments, etc.; and the concluding chapter discusses the construction and calibration of instruments, such as the tangent galvanometer and those used for measuring pressure and regulating resistance. Tables of electro-chemical equivalents of the more important elements, of thermo-chemical data, and of wire resistance, are appended.

The second book, as its title implies, is in part of a more practical character. The first forty pages are given again to a discussion of instruments, but the remainder is devoted to a discussion of simple electro-chemical experiments, such as electrolysis of hydrochloric acid with and without a diaphragm; electrolysis of dilute sulphuric acid, or sodium hydroxide, with a diaphragm; formation of persulphuric acid by the electrolysis of sulphuric acid; precipitation of copper under different conditions; precipitation of magnesium from a fused salt of the metal; the number of processes involved being sufficient to give some idea of electro-chemical operations.

The final chapter, on 'Organic Electrolysis,' was written by Professor Elbs and is one of the most interesting chapters in the book. In a very few experiments it gives some idea of the application of electrolysis to organic chemistry, an idea which is, however, greatly enlarged by such a work as the third volume of Peters' 'Angewandte Elektrochemie.'

The translation by Professor Smith is especially welcome, not simply because of his skill in such work, but since it comes from the leading authority in practical electro-chemistry in America.

H. C. J.

SCIENTIFIC JOURNALS.

The Journal of Geology, May–June, 1898: The number opens with 'A Symposium on the Classification and Nomenclature of Geologic Time-Divisions,' a contribution that is based on a series of fourteen questions that had been submitted to the geologists mentioned below. The questions involve a discussion of the extent to which subdivision should be pursued in the time and physical scales, and of the number of geological periods (as the word period was used by the Berlin Congress) which it is desirable to adopt. Considerable difference of opinion is developed, so much so as to make the average teacher impatient with this continual tinkering with words. Opinions are expressed by Joseph Le Conte, G. K. Gilbert, W. B. Clarke, S. W. Williston, Bailey Willis, C. R. Keyes and Samuel Calvin. 'Probable Stratigraphical Equivalents of the Coal Measures of Arkansas,' by C. R. Keyes. The author cites the great thickness of the Arkansas Coal Measures as compared with those of Iowa and Missouri, *i. e.*, 2,400 feet as against 500–600, and strongly opposes the ordinary conception of the Ozark island of Carboniferous and later time. He emphasizes the evidence that land conditions followed the deposition of the St. Louis limestone and preceded the formation of the Iowa and Missouri Coal Measures. He explains the greater thickness of the Arkansas measures by their continuity of deposition without regard to this change on the north. A paper 'On the Origin of certain Siliceous Rocks' is presented in two parts. The first, by O. A. Derby, contains 'Notes on Arkansas Novaculite,' and gives the results of an investigation of the novaculite by crushing it to slimes without destroying the larger included grains of secondary quartz. The slimes were then studied with the microscope, and the author reached the conclusion that an origin by replacement of cherty limestone has great claims to confidence. J. C. Branner, in the second part, comments on these results and systematically reviews the explanations that have beeen advanced for the siliceous rocks. He adds a few notes on those in California. 'A Study of Some Examples of Rock Variation,' by J. M. Clements, deals with an interesting series of eruptives at Crystal Falls, Mich., which follow the Upper Huronian and precede the Potsdam. The series consists of quartz-diorite, hornblende-gabbro, bronzite-norite and peridotite, and is described in detail with analyses. The hornblende-gabbro was first in time; then came the norite and peridotite, and, last of all, the diorite with transitions into granite. Under the 'Studies for Students' a good brief review of the development and geological relations of the fishes is given by E.

C. Case. It is meant to be the first of a series on vertebrates. Editorials and reviews close the number.

The Journal of Geology, July–August, 1898: 'The Ulterior Basis of Time Divisions and the Classification of Geologic History:' T. C. Chamberlin. Apropos of the symposium in the last number the author seeks some world-wide parallel, geologic phenomena which may afford a suitable basis for geological classification. He urges the possible validity of great geologic disturbances, which he argues are in the nature of general shortening of all the radii of the earth, but of comparatively greater shortening of those under the sea bottoms. The effects on the regions of sedimentation and continental encroachment on the sea are indicated. 'The Post-glacial Connecticut at Turner's Falls, Mass.:' M. S. W. Jefferson. The paper describes the interesting rearrangements of drainage lines along the Connecticut river near the famous 'bird-track' quarries. The agency of ice is invoked to explain the two abandoned channels, with their former waterfalls and potholes, which now are ponds. 'The Variations of Glaciers, III.:' H. F. Reid. Reports during 1897 to the International Committee indicate a marked retreat of glaciers in general, with one or two small advances in Scandinavia. 'Notes on the Kalamazoo and other Old Glacial Outlets in Southern Michigan:' C. H. Gordon. The paper deals with several abandoned river channels and their relations to the modern streams. The region lies along the general latitude of Port Huron and extends from Lake Huron to Lake Michigan. The paper is accompanied by a map whose excessive reduction taxes the eyesight beyond reason. 'Notes on some Igneous, Metamorphic and Sedimentary Rocks of the Coast Ranges of California:' H. W. Turner. This valuable contribution takes up first the metabasalts and diabases of the Coast Ranges. More or less altered rocks are traced back to original, eruptive diabases, although in some instances they had been regarded previously by geologists as metamorphosed sediments, *i. e.*, pseudo-diabases. Observations on serpentines are also given. The author next discusses the Franciscan, or Golden Gate formation. This contains the interesting blue amphibole (glaucophane) schists that are generally familiar to petrographers. The age of the formation is thought to be older than that of the Knoxville, *i. e.*, to be Jurassic. An argument is made against the necessary origin of the blue schists by contact metamorphism. The San Pablo formation is next taken up and its stratigraphical position is discussed on the basis of fossils. Comparisons are drawn with the auriferous gravels. Under the 'Studies for Students,' E. C. Case continues his brief review of the development and geological relations of the vertebrates, and treats of the Amphibia and Reptilia. Editorial remarks, a number of summaries of pre-Cambrian literature and reviews close the number.

NEW BOOKS.

The Tides, and Kindred Phenomena in the Solar System. George Howard Darwin. Boston and New York, Houghton, Mifflin & Co. 1898. Pp. xviii+378.

A Manual of Chemical Analysis. G. S. Newth. New York and London, Longmans, Green & Co. 1898. Pp. xii+462.

Manual of Determinative Mineralogy with an Introduction on Blowpipe Analysis. George J. Brush. Revised by Samuel L. Penfield. Fifteenth Edition. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1898. Pp. x+312.

Elementary Zoology. Frank E. Beddard. New York and London, Longmans, Green & Co. 1898. Pp. vi+208.

Lecture Notes on the Theory of Electrical Measurements. William A. Anthony. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1898. Pp. vi+90. $1.00.

Human Immortality; Two Supposed Objections to the Doctrine. William James. Boston and New York, Houghton, Mifflin & Co. 1898. Pp. 70. $1.00.

The Copper Dam Process for Piers; Practical Examples from Actual Work. Charles Evan Fowler, Bridge Engineer. New York, John Wiley & Sons. 1898. 8vo. Pp. xv+159. $2.50.